Annual Report 2020

ICAR- Vivekananda Parvatiya Krishi Anusandhan Sansthan
(ISO 9001:2015 Certified Institute)
Almora-263 601, Uttarakhand (India)
www.vpkas.icar.gov.in

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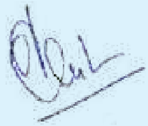
PREFACE

The innovations have been major driving force to achieve growth and development in agriculture and allied sectors that have enabled us to achieve self-sustaining food security with appropriate measure of resilience even in times of natural calamities. Presently agricultural development in hills is facing several challenges such as dwindling natural resources, climate change, migration, fragmentation and diversion of agricultural land to non-agricultural uses, poor marketing facilities, globalization and liberalization. Still, value added nutri rich traditional & speciality crops, organic agriculture, improved varieties, cultivation methods, efficient machines, effective diffusion techniques and other allied activities provide excellent opportunities in hills. Agriculture in the Himalayan region is slowly diversifying from traditional cereal based system to a blend of cereal and commercial crops like fruits and vegetables-based system, which in turn is increasing farmers' income as well as demand for fresh innovations in productivity, natural resource management, mechanization, health and nutrition of farmers, etc.

The institute is working continuously making conscious efforts to meet the changing demand of hill agroecosystem in the era of climate change and globalization. The institute has implemented Government of India scheme to provide best technologies to the hill farmers. The special population of Scheduled Tribes and Scheduled Caste farmers is being served through the TSP and SCSP programmes in the unprivileged remote locations. The technology basket of the institute, through its outreach activities, reached even to the far flanged villages in North Eastern Himalayan regions through NEH programme. The Institute worked on various aspects of yield improvement of agricultural and vegetable crops, their protection and processing. In addition, focus on water harvesting, nutrition and drudgery reduction of women farmers, off-farm income generation, use of solar energy in farm mechanization, innovative extensions using ICT were more precise and location specific. Several new technologies were tested and were introduced based on their effectiveness and ease of use. The positive feedback from farmers and other stakeholders encourage the institute to move forward with stronger commitment.

Seed plays important role in increasing production. It was ensured by the institute that all the indented requirements of breeder seed are fulfilled. The institute provided material and technology support to farmers in the far-flung areas of North West and North East Hills. The last year had been a difficult time due to COVID 19 lockdown. In spite of this, institute left no stone unturned in catering the needs of farmers, extension workers, entrepreneurs, seed agencies and research organizations associated with hill agriculture during the period through digital and virtual platforms like e-trainings on IPM, fall armyworm management for KVK personnels of North west and North East Himalayan regions and virtual Kisan Mela for farming community.

I wish to place on record my sincere gratitude to the Secretary (DARE) & Director General (ICAR), Additional Secretary (DARE) & Secretary (ICAR), Financial Advisor (DARE) for their encouragement. I am obliged to the Deputy Director General (Crop Science) and Assistant Director General (Seeds) for their wholehearted support and guidance to ICAR-VPKAS. I express my sincere appreciation to the Editorial Board, PME Cell, all my colleagues and staff members of the institute for their dedicated effort and unflinching cooperation in carrying out various activities of the institute.



Place: Almora
Date: March 2021

(Lakshmi Kant)
Director

Unity of Life in the words of Padamabhusan Professor Boshi Sen

Padamabhusan Professor Boshi Sen
1887 to 31.08.1971

"Since we are hoping to evolve our conception of the unity of life let us inquire, 'What is life? To our primitive ancestors anything moving was living- the Sun, the Moon, the rushing river, the hurricane. Our legacy has been many poetic imageries. As our knowledge increases alike in depth and extent, we find it extremely difficult to define life. We say life is something that happens. But we do know that life starts its career with a single cell. Some forms of life even end their cycle as an individual cell."

"The higher we ascend in the evolutionary scale, we find multi-cellular organisms. These also begin with an individual cell. After fertilization, it multiplies and differentiates and develops into the adult structure. With this simple beginning, diverse structures and organs are formed with specified functions – attaining the climax of complications in man."

"From the study of the forms, diversity and not unity would seem to be the scheme of life. But form is not all of life. Life has other functions. To develop a living thing, it must gather energy from outside and transform it to make it its own and must also eliminate the unusable excess. To survive, it must adjust itself to the ever-changing environment. It is from the survey of functions that the unit emerges as an individual organism. The different organs of the body do not work for different masters but for the organism."

"But man is not content with merely surviving. There is something in us which propels us, consciously or unconsciously to our higher destiny. Thought and feeling are at once our great encumbrances and assests. These lead us on to dismal depths and rare altitudes. Is there any integarting background for our thoughts and emotions? That is the subjective background of our being. To know this, we have to become both the subject and object of investigation- the capacity to isolate the object of investigation from the external disturbances and at the same time the capacity to perceive with greater minuteness and refinement. This in plain words means control of our senses. With perfect control of our senses, a unity of a different quality emerges and is felt with the whole being. Then we perceive our real nature, which is full of bliss – existence, knowledge and bliss absolute."

(Taken with the permission of Author of the book – ***Nearer Heavan than Earth – The Life and Times of Bosi Sen and Gertrude Emerson Sen)***

CONTENTS

INTELLECTUAL PROPERTY INDIA
PATENTS | DESIGNS | TRADE MARKS
GEOGRAPHICAL INDICATIONS

सत्यमेव जयते

क्रमांक : 011122462
SL No :

भारत सरकार
GOVERNMENT OF INDIA
पेटेंट कार्यालय
THE PATENT OFFICE
पेटेंट प्रमाणपत्र
PATENT CERTIFICATE
(Rule 74 Of The Patents Rules)

पेटेंट सं. / Patent No.	:	336230
आवेदन सं. / Application No.	:	1627/DEL/2008
फाइल करने की तारीख / Date of Filing	:	08/07/2008
पेटेंटी / Patentee	:	INDIAN COUNCIL OF AGRICULTURAL RESEARCH
आविष्कारक (जहां लागू हो) / Inventor(s) :	:	1.DR. MUTHUGOUNDER MOHAN 2.DR. SATYA NAND SUSHIL 3.DR. JAGDISH CHANDRA BHATT 4.DR.SUPRADIP SAHA 5.DR.HARI SHANKER GUPTA

प्रमाणित किया जाता है कि पेटेंटी को उपरोक्त आवेदन में यथाप्रकटित A process for mass production of Bacillus thuringiensis (Bt) biocide using Millet grain based agro-medium नामक आविष्कार के लिए, पेटेंट अधिनियम, १९७० के उपबंधों के अनुसार आज तारीख 8th day of July 2008 से बीस वर्ष की अवधि के लिए पेटेंट अनुदत्त किया गया है।

It is hereby certified that a patent has been granted to the patentee for an invention entitled A process for mass production of Bacillus thuringiensis (Bt) biocide using Millet grain based agro-medium as disclosed in the above mentioned application for the term of 20 years from the 8th day of July 2008 in accordance with the provisions of the Patents Act,1970.

THE PATENT OFFICE
GOVT.OF INDIA
पेटेंट कार्यालय
भारत सरकार

अनुदान की तारीख :
Date of Grant : 29/04/2020

पेटेंट नियंत्रक
Controller of Patent

टिप्पणी - इस पेटेंट के नवीकरण के लिए फीस, यदि इसे बनाए रखा जाना है, **8th day of July 2010**को और उसके पश्चात प्रत्येक वर्ष मे उसी दिन देय होगी।

Note. - The fees for renewal of this patent, if it is to be maintained will fall / has fallen due on **8th day of July 2010** and on the same day in every year thereafter.

2 nd Patent (No. IN336230) for mass production of *Bacillus thuringiensis* (Bt) biocide using millet grain based agro-medium.

Executive Summary

During the period, 7 varieties of different crops were notified. These include one centrally released variety of lentil VL *Masoor* 148 (1,148 kg/ha) and one variety of cherry tomato VL cherry tomato 1 (2,500-3,000 kg/ha in open field conditions and 4,000-5,000 kg/ha under polyhouse conditions). VL cherry tomato 1 is the first variety of cherry tomato developed in the country through CVRC. The notified quality protein hybrid of maize VL QPM hybrid 59 is the second biofortified MAS derived QPM hybrid by the institute with enhanced lysine (0.33%), tryptophan (3.33%) and protein content (8.91%). The other notified varieties include VL *Gehun* 2015 (1,988 kg/ha) of wheat for timely sown rainfed organic conditions of Uttarakhand hills in the main cereal group. In pulses, black soybean variety VL *Bhat* 202 (1,596 kg/ha) was released for organic conditions of Uttarakhand hills. Similarly, VL *Matar* 61 of field pea was notified for timely sown rainfed conditions of Uttarakhand hills. Likewise, in vegetables, VL *Sabji Matar* 14 (1,250 kg/ha) with maturity duration (126-132 days) in mid hills is notified for organic conditions of Uttarakhand.

Apart from this, 3 varieties of nutricereals–two in finger millet and one in grain amaranth were released for rainfed organic conditions of Uttarakhand hills. In finger millet, VL *Mandua* 382 (1,100-1,500 kg/ha) is the first white grain finger millet variety released for Uttarakhand. It's a medium duration (110-116 days) variety with high calcium (345 mg/100 g), protein (8.1%) and moderate resistance to finger and neck blast. VL *Mandua* 378 (2,296 kg/ha) is the brown grain, blast resistant finger millet variety released for rainfed organic conditions of Uttarakhand hills. VL *Chua* 110 (1,420 kg/ha) is a grain amaranth variety released for rainfed organic conditions of Uttarakhand hills. Likewise, in rice VL *Dhan* 210 (2,157 kg/ha) and VL *Dhan* 211 (2,088 kg/ha) were released for rainfed upland spring sown organic conditions of Uttarakhand. To popularize the newly developed varieties, front line demonstrations (FLDs) were conducted in a total of 25.0 ha area across the state and other parts of North West Himalaya. The newly released cultivars of various crops recorded a yield advantage of 18 to 53% over the ruling varieties in farmer's field. During the period, 30.4 t seeds of various categories were produced and 24.4 t seeds were supplied to seed producers and farmers. These seeds were supplied to clients across various states in India for both production and research purpose.

Studies on maintaining soil fertility as well as sustainability of rainfed soybean-wheat cropping system indicated that economic optimum wheat equivalent grain yield of 10,234 and 10,360 kg/ha through farmyard manure (FYM) and vermicompost (VC) were produced with application of 38.5 and 36.5 kg P/ha, which were 26 and 27% higher than the recommended NPK, respectively. The soil respiration increased as the level of FYM and VC increased up to 52.4 kg P/ha. The highest wheat equivalent grain yield of 14,347 kg/ha was recorded with application of FYM @ 300 kg N/ha, which was 18% higher than the NPK plot. The analysis of grain yield data after 47 years of experimentation under rainfed soybean-wheat system confirmed that the application of FYM along with inorganic fertilizer provided an increase in the wheat equivalent grain yield than the first year (1973-74). Long term field experiment revealed that combined application of organic and inorganic fertilizers (NPK + FYM) significantly improved organic (94%), inorganic (70%) and total phosphorus (78%) content compared to sole application of NPK, respectively. Bacterization of lentil (VL *Masoor* 507) seeds with cold tolerant PSB *Pseudomonas fragi* CS11RH1 recorded maximum grain yield of 1,567 kg/ha over the uninoculated control (1,350 kg/ha). Treatment of lentil (VL *Masoor* 507) seeds with cold tolerant P solubilizing bacterial consortium C2 recorded highest grain yield of 1,629 kg/ha as compared to uninoculated control (1,266 kg/ha).

Among sowing methods, seed drill sowing resulted 9.2% higher wheat grain yield than normal line sowing (3,181 kg/ha) and 12.5% higher than farmer's practice (2,957 kg/ha). Mulching through hoeing resulted 11.8% higher yield than no mulch (3,141 kg/ha). The 69 zero tillage (3,388 kg/ha) gave 3.8% more grain yield than the conventional tillage (3,264 kg/ha). The higher walkley black soil carbon (WBSC) was recorded under zero tillage (6.17 g/kg) and mulching (6.30) over conventional tillage (5.98 g/kg) and no mulching (5.86 g/kg) in 0-15 cm soil layer. Two sprays of lihocin @ 0.2% + folicur @ 0.1% at first node and flag leaf stage (8,058 kg/ha) along with application of 180-90-60 kg/ha N-P_2O_5-K_2O provided significantly higher grain yield than the rest treatments, which was 8% higher than without application (application of 180-90-60 kg/ha N-P_2O_5- K_2O only).

Bacterization with cold tolerant PGP *Pseudomonas* sp. NARs9 recorded higher grain yield of 2,720 compared to uninoculated control (2,108 kg/ha). However, VL *Gehun* 953 achieved higher yield (2,721 kg/ha) with PGP *Pseudomonas* sp. PPERs23 over the uninoculated control (2,596 kg/ha). Bacterization with cold tolerant PGP consortium C4 recorded higher grain yield of 3,513 and 4,013 kg/ha for VL 804 and VL *Gehun* 953, respectively over uninoculated control (2,476 & 3,139 kg/ha). However, VL *Gehun* 907 achieved higher yield (3,038 kg/ha) with consortium C2 over the un-inoculated control (2,502 kg/ha).

Digital Elevation Model (DEM) was developed for delineation of watershed and stream, and fifteen water harvesting sites were identified in the catchment. Both, agronomical (Napier) and mechanical (Trench) measure were applied to efficiently harvest the runoff. Among the different grass systems, love grass and hybrid napier were found to be most effective in controlling runoff (51.32% & 52.83%) and soil loss (14.18 and 15.44 t/ha/yr) in a sloping land (43% slope).

Design for the development of VL Maize sheller was accomplished using Creo Parametric 4.00 (CAD Software) with average shelling capacity and efficiency of 305 kg/h and 98% respectively at 14% moisture content and 10 degree working slope. The speciality of this sheller was threshing of maize cobs without breaking of the cob wood. Famers use this whole cob as fuel wood in their domestic use.

"VL Foot Operated Hand Wash Device" was designed and developed for washing hands without touch. It was found very useful in current scenario of COVID-19 outbreak for minimizing CORONA virus spread, especially in community areas. Water saving percentage of the developed device was approximately 418% compared to conventional tap water used in domestic purpose.

Forage grass availability in hills Bajra Napier hybrid grass entry VTBN 119-16 produced significantly higher green and dry fodder (31,309 kg/ha and (8,348 kg/ha) respectively, whereas, entry IVTO MC-2 produced significantly higher green fodder (23,187 kg/ha). Barseem entry IVTB-1 produced significantly higher green fodder 18,400 kg/ha and dry fodder (3,660 kg/ha) compared to rest entries. In maize entry IVTM-10 produced, significantly higher green forage (35,416 kg/ha) and dry fodder (7, 672 kg/ha) than rest of the entries. In fruit based agri-horti system, under trees, the grain yield of soybean and wheat reduced from 14.6 to 36.3% and 6.7 to 34.1%, respectively. The soil available nutrients under oak-based silvi-horti system, among various cutting management options, the highest N content (~493 kg/ha) was recorded with pollarding at 3 m height which was 1 to 3% higher than other cutting treatments and ~7% than open (461 kg/ha). Total biomass C of the peach tree was 22.9 Mg/ha, in which 75 contribution of aboveground biomass C and belowground biomass C were 79.3% and 20.6%, respectively. Mean wheat equivalent grain yield (WEGY) was significantly higher in sole cropping (5.60 t/ha/year) that was 15.70% more than under peach. However, total (crop + peach) mean gross return was more than three-fold higher under peach as compared to in sole cropping.

Under conservation agriculture practices direct sown rice-wheat rotation, higher wheat yield was recorded under zero tillage plots (3,598 kg/ha) in comparison to conventional plots (3,048 kg/ha). Application of recommended NPK+10 t FYM recorded significantly higher wheat grain yield (5,046 kg/ha). The application of NPK+ FYM in *rabi* season gave highest yield (2,294 kg/ ha) of soybean followed by direct application of recommended NPK fertilizer (2,145 kg/ ha) during both *kharif* and *rabi* season followed by N+FYM and FYM. The urease activity (µg urea-N hydrolyzed g1 soil/h) was found highest under NPK+FYM (253) followed by N+FYM (251) and FYM (248) while lowest in control (230) treatment. Tillage and irrigation management in direct seeded rice-wheat rotation revealed that the significantly higher wheat yield and applied water productivity (3,598 kg/ha and 3.68 kg/m^3) was obtained under zero tillage in comparison to conventional tillage (3,049 kg/ha and 3.06 kg/ m^3).

LDPE film covered with cement and stone/ gravel blocks (made locally)+soil found very economical and suitable and with long life. The economical, suitable and durable block was designed to cover vertical ponds without slope. The total water capacity 4,177.9 m^3 which in including this 50 m^3 developed this year AICRP on Irrigation water management project. The modified drip system has been installed in current year to cover 100 m^2 field areas, the two movable polyhouses are being constructed at farmers field.

During the year, severe infestation of fall armyworm (*Spodoptera frugiperda*) was noticed across the maize growing areas of Uttarakhand. Whereas, low to moderate infestation of *Tuta absoluta* was found on tomato. Frogeye Leaf Spot (FLS) on soybean reached up to 77.7% infection index in susceptible entries by September. In maize, turcicum leaf blight and rust were moderate to severe. The incidence of brown spot caused by *Physoderma maydis* was also observed in moderate form in experimental trials. The severity of leaf, neck and finger blast of finger millet was found moderate to severe. In barnyard millet moderate to high incidence of grain smut disease was observed at farmer's fields. In wheat and barley, yellow rust severity was medium to high (20S to 80S) at experimental farm, Hawalbag however, at farmers field it was low.

The yellow rust samples analyzed at IIWBR regional station Flowerdale showed the dominance of pathotype 238S119. However, brown rust samples collected from Uttarakhand, showed that pathotypes belonging to 77-5 followed by 77-9, 77-1, 12-4 and 104-A. Out of 50 rice genotypes, 29 and 21 entries were found highly resistant to leaf and neck blast, respectively.

Out of 23 composite wheat rhizosphearic soil samples and 12 pea rhizosphearic soil samples analysed for prevalence of plant parasitic nematodes, the genera, *Helicotylenchus* was found to be the most predominant in wheat crop while *Pratylenchus* was most abundant in pea. One entomopathogenic nematodes (EPN) against *Corcyra* larvae was identified as *Pristionchus pacificus* based on the morphology and molecular approach.

During May to October, the trapped beetle diversity comprised of 60 species predominated by *Anomala* spp. (14.28%). The catches of *Anomala dimidiata* were found to have decreased over previous year and became the third most predominant species. Among surveyed locations for prevalence of whitefly population, *Trialeurodes* spp. was widely distributed in cold and temperate climates, whereas, *Bemisia* spp. was distributed mostly in hot and humid climates. Molecular characterization (based on ITS region) of entomopathogenic fungi, *Alternaria* spp. strain VLH1 showed maximum homology of 99.81% with *Alternaria alternata* strain ZH2-5. In Bio-efficacy of commonly used insecticides against aphid pests Thiomethaxam 25 WG was the most toxic insecticide against *L. erysimi* and *B. brassicae* with LC_{50} of 2.54 ppm and 0.024 ppm, respectively.

Out of 12 siderophore producing *Pseudomonas* strains, *Pseudomonas* sp. NARs9 gave significantly higher yield (1.02 kg/8 kg compost) as compared to untreated control. Among eight siderophore producing and 'P' solubilizing bacterial consortia applied on *Agaricus bisporus,* consortium C4 (CS11RH1, CS11RP1, CS11RH4) gave significantly higher yield (1.87 kg/08 kg compost) in comparison to control.

Participatory on-farm evaluation and demonstration of different production practice were conducted to find out the effect of improved agricultural technology (improved variety and line sowing with recommended plant spacing) on productivity, farmers' preferences for crop variety traits, farmers' preferences for line sowing. Preference score for improved variety (VL *Mandua* 352) was more than the local variety in attributes, *viz*. productivity, head size, seed size, seed colour, lodging and plant height, whereas, preference score related to attributes like taste and maturity was less than the local variety. Similarly, preference score for improved variety (VL *Masoor* 126) was more than the local variety in attributes, *viz*. productivity, disease resistance. Demonstration yield of VL *Masoor* 126 was 950 kg/ha which is 46.1% higher than farmers' yield. Demonstration yield of VL *Masoor* 126 along with line sowing was 60% higher than farmers' yield. Demonstration yield of VL *Gehun* 953 was 23.6% higher than farmers' yield. Demonstration yield of VL *Gehun* 953 along with line sowing was 32.7% higher than farmers' yield. Based on the overall preference criteria, treatment 2 (improved variety along with broadcasting) was preferred by farmers when farmers convenience with weight was also considered in lentil and wheat crops.

Based on nutritional status and dietary diversity scores of farm women, concept of Homestead nutrition gardens (133) as food-based approach is being promoted in low and high hill region of Uttarakhand. Women farm schools were organised to provide training on homestead nutrition garden, drudgery reducing tools, selection of hand tools, good posture and adequate diets and nutritional deficiencies. The change in dietary diversity scores was observed and about 75% women could achieve mean dietary diversity score *i.e.* at least inclusion of 5 types of foods in their daily diets. Some technologies were tested for drudgery reduction in participatory mode using ergonomic techniques. The Rapid Entire Body Analysis technique revealed that the three-row transplanter significantly reduced the discomfort perceived and exertion reported by the farm women while transplanting paddy nursery in comparison to the conventional method. The postural discomfort also reduced significantly by use of the transplanter. Hand hoe with long handle reduced the energy expenditure of women while weeding by 12% and the work pulse by 24%, suggesting that the long handled hoe can be promoted in hill areas for weeding in finger millet for making the activity less drudgery prone. Energy expenditure of women, while threshing wheat reduced (20%) by use of VL Wheat thresher in comparison to manual threshing. Manual wheat threshing, which is a moderately heavy activity to perform (EER:8.8 kJ/min), can be changed to a light activity (EER:7 kJ/min) to perform by use of VL Wheat thresher, thus reducing physiological stress of farmer.

Farm advisory services are provided regularly through toll-free Farmers' Helpline Service (Telephone No. 1800-180-2311), need based SMS service, m-Kisan portal and *Krishi Samridhi* radio programme. Presently more than 4,000 and 700 farmers are registered in m-Kisan portal and institute initiated need based SMS services, respectively. Moreover, scientist and farmers are exchanging valuable information through WhatsApp groups formed by institute. Information is sent to farmers on different contents like varieties, crop protection measures, nutrient management, farmers fairs/field days, seed production, government schemes *etc* benefiting registered farmers.

INTRODUCTION

ICAR-VPKAS, Almora campus

Experimental Farm, ICAR-VPKAS, Hawalbag campus

VPKAS: A Profile

ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan (ICAR-VPKAS), Almora, is a premier institution conducting agricultural research mainly for the hilly region of North-Western (NW) Himalayan states (*viz.*, Himachal Pradesh and Uttarakhand) and Union Territories (*viz.,* Jammu-Kashmir & Ladakh) of India. However, it also extends its technological support to other hilly regions (*viz.,* North Eastern States) of the country. The growth and development of the institute over the years has been phenomenal. Established by Padamabhusan Professor Boshi Sen, the institute originally functioned as a 'one man' laboratory with limited resources. In 1959, the laboratory was transferred to U.P. Government, and subsequently to ICAR in 1974. The institute headquarter is located at Almora (29°33' N and 79°39' E and 1,600 m amsl) in Uttarakhand. The Experimental Farm is located at Hawalbag, 13 km away from Almora on Kausani/Ranikhet Road at an altitude of 1,250 m amsl (29°56' N and 79°40' E).

Being a multi-crop and multi-disciplinary research institute, research work is carried out under four divisions/sections, *viz.*, Crop Improvement, Crop Production, Crop Protection and Social Sciences.

The ICAR-VPKAS, in the last 97 years of service to the nation, has several pioneering achievements to its credit. The most notable ones are:

i. Development of first hybrid of maize (VL *Makka* 54), onion (VL *Piaz* 67) and extra early grain and baby corn (VL *Makka* 42).

ii. Development of dual-purpose wheat varieties (VL *Gehun* 616 and VL *Gehun* 829) for grain and fodder.

iii. Conversion of normal maize inbreds into quality protein maize through molecular marker assisted selection and consequent release of *Vivek* QPM 9.

iv. Development of *Vivek* thresher-cum-pearler for finger and barnyard millet, which has helped in reducing drudgery of the hill farm women.

v. Devising a two-pronged strategy for managing the adult beetles and subterranean larvae of the menacing pest 'white grub'.

vi. Development of completely metallic plough VL *Syahi Hal*, which is helping in checking deforestation.

vii. Development of protected cultivation hub and uplifting daily wage earners to entrepreneurs.

viii. Insect trap (White Grub Beetle Trap) (Patent No: IN290170) patented

ix. Formulation of *Bacillus thuringiensis* (VLBt6) (Patent No: IN336230) patented

1.1 Mission

Enhancing Productivity and Ecological Sustainability of Hill Agriculture through Niche-Based Diversification

1.2 Mandate

- Basic, strategic and adaptive research for improving productivity and quality of important hill crops with emphasis on conservation and efficient utilization of natural resources.
- Development of post-harvest technologies and value addition.
- Dissemination of technology and capacity building on hill agriculture.

1.3. Historical Perspective & Salient Accomplishments

The Institute has made outstanding contribution to crop improvement in the hill region, by developing 160 improved varieties of 25 crops. The most popular varieties are Vivek *Dhan* 154, Vivek *Dhan* 62 and Vivek *Dhan* 82 of rice; VL *Sankul Makka* 31, Vivek Maize Hybrid 45 & 53, Vivek QPM 9, VL *Amber* pop corn, VL Baby Corn 1 of maize; VL *Gehun* 616, VL 804, VL *Gehun* 829 and VL *Gehun* 892 of wheat; VL Barley 56 of barley; VL *Mandua* 352, VL *Mandua* 149 and VL *Madira* 172 of small millets; VL Soya 47 of soybean; VL *Masoor* 126, VL *Masoor* 129 of lentil, VL *Ageti Matar* 7, Vivek *Matar* 10, Vivek *Matar* 11 of garden pea, VL *Rajma* 63 of rajmash, VL *Chua* 44 of grain amranth, VL *Arhar* 1 of pigeon pea and VL *Ugal* 7 of buckwheat. During 2020, cherry tomato **VL Cherry Tomato 1** has been identified by AICRP on vegetable crops for release by CVRC. **This is the first all India identification of a Cherry tomato variety in the country.** The institute has also developed matching production and protection technologies for these varieties.

Since last five years, 25 improved varieties (10 central & 15 state release) of various crops like, wheat (VL *Gehun* 953, VL *Gehun* 967, VL *Gehun* 2014 and VL *Gehun* 3004), maize (Central VL Maize Sweet Corn 1, Central Maize VL Baby Corn 2, Central Maize VL 55 and Vivek Maize Hybrid 57 & VL Sweet Corn Hybrid 2), barley (VLB 94 & VLB 130), rice (VL *Dhan* 156 & VL *Dhan* 158), millets (VL *Mandua* 348, VL *Mandua* 376, VL *Mandua* 378, VL *Mandua* 379, VL *Mandua* 380 & VL *Mandua* 382), grain amaranth (VL *Chua* 110), oilseeds (VL Soya 77, VL *Bhat* 201, VL *Bhat* 202, VL Soya 89) and vegetable (VL *Sabji Matar* 13 and VL *Sabji Matar* 15) were released for cultivation.

In addition, 11 high yielding disease resistant varieties have been identified for release at central/ state level. These include rice (VL *Dhan* 210, VL *Dhan* 211 and VL *Dhan* 159) soybean (VL *Bhat* 202, VL *Soya* 76), lentil (VL *Masoor* 148, VL *Masoor* 150), field pea (VL *Matar* 64), finger millet (VL *Mandua* 378, VL *Mandua* 391) and barnyard millet (VL *Madira* 254). During last five years, 838.25 q of breeder, 64.65 q of nucleus and 63.13 q of truthfully labelled seeds were produced for various agencies and farmers.

These varieties recorded potential yield improvement ranging from 9.3 to 26.1%. In addition, some value addition (like sweet and baby corn, high calcium grain millet) were done through these varieties. Working towards quality improvement, two inbreds (CM 212 and V 373) were converted to QPM and sweet corn sequentially. A new hybrid developed from such inbreds VL Sweet Corn 2 has been notified for release. Similarly, through marker assisted selection in maize, 22 inbreds for kernel β-carotene (<10 ppm), 10 inbreds for high Fe content (<50 ppm) and 20 inbreds for low phytate (phy 55-63% of total P) have been developed. In wheat, *Yr10* and *Lr24* genes have been pyramided in VL *Gehun* 907 and VL *Gehun* 892. Presently 16,805 native and exotic accessions of 25 different crops are being maintained at the institute gene bank.

The matching agro-techniques for realizing full potential of improved varieties of crops and managing the constraints were standardized. Cropping sequence, spring rice–wheat–finger millet–toria attained 200% cropping intensity against 150% of the traditional spring rice–wheat–finger millet–fallow sequence in two-year cropping system. Among one-year crop sequesnces, soybean–lentil, maize–pea, maize–wheat, rajmash-french bean–toria, pigeon pea–wheat, colocasia–coriander–tomato, soybean–pea and soybean–wheat was found more remunerative. Intercropping of soybean or groundnut in maize, soybean in finger millet and pea, lentil or toria in wheat were found more profitable than pure crops.

Long term fertility management, being studied since 1973, revealed that use of FYM (10 t/ha) along with the recommended dose of inorganic fertilizers was capable of rectifying nutritional problems of crops and the deterioration of soil physical conditions.

Under fodder and grassland management, suitable agro-forestry systems, species of grasses (including winter grasses), fodder legumes, and grass composition under pine and deodar trees were identified. Technologies for production of grasses on risers, steep slopes, degraded and marshy land were also developed. In addition, cultivation of turmeric under pine forest, sloping silvi-horti and oak high density plantation have been introduced.

Low cost polyhouse technology has been developed for protected cultivation. Crops and seedlings can successfully be grown during winter in the polyhouses, which, otherwise, is not possible outside due to prevailing low temperature. Package of practices for growing vegetables under low cost polyhouse have been developed and standardized. Low cost LDPE film-lined water storage tank, conveyance system and drip irrigation system have been developed for growing off-season high value vegetables.

Survey of Kumaon and Garhwal regions show prevalence of yellow and brown rusts, loose smut, powdery mildew and hill bunt in wheat; stripe disease and covered smut in barley; blast, brown spot and false smut in rice; neck and finger blast in finger millet; turcicum leaf blight in maize; powdery mildew and white rot in pea; buckeye rot in tomato, root rot and anthracnose in bean; root rot and wilt in lentil, and frogeye leaf spot as well as anthracnose. Viral diagnosis, based on symptomatology, showed presence of nearly 50 viral diseases affecting different crops grown in hills. Constant vigil is kept to prevent wide-spread damage by new pests like tomato pin worm, fall army worm etc. Indigenous *Trichoderma* strains have also been isolated from the NW Himalayan region and found effective against the soil borne pathogens.

White grub, a polyphagous pest, which devastates several rainfed *kharif* crops, is the most menacing insect of the region. More than 75 species of this insect have been recorded in Uttarakhand. Insect trap (Patented: IN290170) and the entomopathogenic *Bacillus cereus* WGPSB2 are the potential technologies to manage the white grubs. In addition, stem borer and leaf folder in rice and small millets; hairy caterpillar and sucking bug in soybean; leaf miner in garden pea and pod borer in pea and gram; fruit borer in tomato; blister beetle in beans and pigeon pea are other major pests. Management technologies have been evolved for major diseases and insects in important crops with emphasis on evaluation of germplasm for resistance/tolerance, manipulation of cultural practices, use of locally available plant extracts and need-based application of pesticides.

The invention process for the mass production of *Bacillus thuringiensis* (Bt) biocide using millet grain based agro-medium for the early, profuse sporulation and the process for the mass production of bio-insecticide, *Bacillus thuringiensis* has been granted patent (No. IN336230).

Demonstration of improved agricultural production technology was the major programme for agricultural development of the hilly states. More than 4,000 field demonstrations were conducted to show the benefits of latest agro-technology in the villages adopted under various programmes.

A survey of the economics of off-season vegetables indicated that producer receives only 13-21% of consumer's money in different vegetables and the lion's share is siphoned to the middlemen in the prevailing marketing system, which indicates the need to develop marketing system by the farmers themselves, e.g., by forming a cooperative marketing society. Two FPOs developed by the institute are serving as models for effective marketing system.

The institute has to its credit a technological options publication entitled, "उत्तर पश्चिमी पर्वतीय क्षेत्रों में कृषि उत्पादकता की वृद्धि के लिए उन्नत तकनीकें" which is very popular among farmers and extension workers. The publication was awarded prestigious **Dr. Rajendra Prasad Purushkar** of Indian Council of Agricultural Research in the year 2004. E-books have been created for important technological bulletins. *Vivek* Thresher 1 for pearling and threshing of *Mandua/Madira* won **NRDC's Meritorious Invention Award** for the year 2006 by National Research Development Corporation (NRDC), New Delhi and Institute's scientists won **Hari Om Ashram Trust Award 2007** of ICAR for this invention. A team of scientists won **Outstanding Team Award of ICAR** as a recognition to the work in the area of enhancing productivity and profitability of rice-wheat system in NW Himalayan States. Scientists of the institute also received **World Intellectual Property Organization (WIPO) Gold Medal in 2009**, for development of "Eco-friendly novel technology for managing white grubs in North West Himalayas" which was identified as the **best invention of the year 2008**. This work also won the **Societal Innovation Award of NRDC in 2008**. In 2010, the institute scientists got **ICAR Outstanding Team Research Award in the subject area of**

Natural Resource Management. The Institute received **Mahindra Krishi Samridhi India Agri Award 2012** for its outstanding contribution in the development of agricultural technologies and their popularization among farmers. The Institute has been judged as the **best institute for Application of plastics in Agriculture under AICRP and** received **appreciation** from **IIMR** for its **outstanding contribution in maize improvement.** The institute has been honoured for the development of **landmark varieties of maize (VL *Makka* 54 and HIM 128)** and **wheat (VL *Gehun* 421)** during the Platinum Jubilee Celebration of ISGPB on February 11, 2017. These varieties contributed towards food and nutritional security of the country. The Institute has been adjudged as the "**Best Performing Centre Award" for the year 2017-18 for small millets research**. On 91st Foundation Day Function of Indian Council of Agricultural Research, the scientists of ICAR-VPKAS, Almora were conferred three national awards. The first award, **Fakhruddin Ali Ahmed Award for Outstanding Research in Tribal Farming Systems**. The second award, **Pandit Deen Dayal Upadhyay Zonal Krishi Vigyan Protshahan Puraskar**, was given to Krishi Vigyan Kendra, Chinyalisaur (Uttarkashi) for its outstanding work in the area of agricultural technology extension and farmers training among 71 KVKs of union territories (Jammu-Kashmir, Ladakh) and states (Himachal Pradesh, Punjab and Uttarakhand) in Zone I. KVK, Bageshwar was given Second Best KVK Award 2019 in Zone I. During the year 2nd patent on formulation of *Bacillus thuriengensis* (VLBt6) (Patent No. IN336230) granted.

A hybrid maize—Pusa Vivek QPM 9 Improved that is claimed to be the world's first ever rich in lysine and tryptophan as well as pro-vitamin A was developed as a collaborator with IARI, New Delhi. Normal maize kernels have 8-10% protein and, within that, 1.5-2.5% lysine and 0.3-0.4% tryptophan. Pro-vitamin A content, too, is only 1-2 parts per million (ppm). The new maize hybrid has 2.67% lysine and 0.74% tryptophan in the protein (as was in Vivek QPM9), besides 8.15 parts ppm of pro-vitamin A. The improved version retains the *Opaque-2* gene that enhances lysine and tryptophan content, and another gene *crtRB1*, which results in higher levels of carotenoids (β-carotene, alpha-carotene and β-cryptoxanthin) that convert into vitamin A in the body.

The bio-fortified hybrid is not genetically modified, as both the *Opaque-2* and *crtRB1* genes are incorporated from maize lines and not any alien/unrelated plants or microorganisms. It has been mainly developed for J-K, Ladakh, Himachal Pradesh, Uttarakhand and the North-East states (original recommendation zone of Vivek QPM9) with 93-95 days maturity and average and potential yield of 5.6 and 8 tonnes per hectare, respectively. It is also suited for growing in the southern states and Maharashtra, where the average and potential yields are higher (5.9 and 9.4 tonnes) with only 83-85 days duration.

1.4. Insitute Facilities

Laboratories and Research Farm

The institute has well-equipped facilities for biotechnology, agricultural chemistry and microbiology at Almora and Boshi Sen Field Research Platinum Jubliee Laboratory with plant breeding, entomology, plant pathology, agronomy, soil science, quality testing, agricultural engineering laboratories, seed processing plant and germplasm storage module at Hawalbag.

Research Farm

Prof. Boshi Sen Field Research Laboratory and Research Farm is located at Hawalbag about 13 km from Almora on the Almora-Kausani-Ranikhet Road at an elevation of 1250 m above mean sea level. The Research Farm of the Institute has 92 ha of total land with about 44.5 ha (including fodder) of cultivable land. In addition, a number of new laboratories were developed to accommodate the activities of various disciplines in the Field Research Laboratory at Hawalbag. These include short-term cold storage module, post-harvest technology unit, mushroom composting tunnel, high tech polyhouses *etc.*

Fabrication Workshop Cum Training Centre or Incubation Centre – Cum - Fabrication Unit

During 2018-19, the Institute has established one worshop cum training centre under the Scheduled Cast Sub Plan (SCSP) programme. The centre has been established to update the skill of local blacksmiths/artisans and to train the unemployed youth of the Scheduled Cast (SC) in the field of mechanization. The centre has been equipped with major machines like lathe machine, shaper machine, numerically controlled hydraulic sheet cutting machine, milling machine, radial drill machine and other small day to day use machines/tools.

Institute Library

A total of 4,210 books of various subjects related to the scientific activities of the institute are available in the library, besides reports and bulletins received on exchange /complementary basis from other institutions of the country and abroad. The library subscribed 16 foreign and 57 Indian periodicals until 2016. At present the library subscribes to 10 Indian journals. There are about 4,000 bound periodicals in the library. The library is also providing current awareness service to the scientist of the institute and other outside research and development professionals visiting the institute. The Institute as a whole is a member of ICAR e-resource network CeRA.

Agricultural Knowledge Management Unit (AKMU)

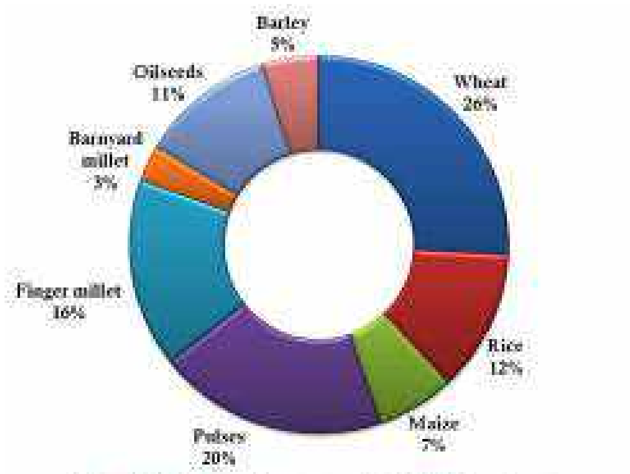
Local Area Network has been set up at the institute consisting of more than 100 nodes with 50 Mbps Internet Lease line connections at Almora and 10 Mbps at Hawalbag. AKMU maintains institute website which can be accessed at http://vpkas.icar.gov.in. AKMU also provides toll free Farmers' Helpline Service for farmers. Farm advisory services are provided regularly through toll-free Farmers' Helpline Service (Telephone No. 18001802311). Institute is also serving farmers through need based mobile SMS service since July 2016. Farmers are registered for receiving SMS and are grouped based on crop grown, location and activities engaged in. Presently more than 700 farmers are registered for the service. Need based information are sent to farmers on different contents like varieties, crop protection measures, nutrient management, farmers fairs/field days, seed production, government schemes etc.

IPT&M Unit

The unit co-ordinates activities of institute technologies. To showcase institute technologies to industry and other stakeholder for further mass multiplication and commercialization through Agri-innovate India Ltd, New Delhi. In addition, material transfer Agreement (MTA) was signed for commercialization of "Vivek Maize Hybrid 45" and "Vivek Maize Hybrid 53" with *Bhartiya Beej Nigam* Limited for 5 years, Technology License Agreement (TLA) was signed for commercialization of for "VL Small Tool Kit" with M/s Himalayan Hi-Tech Nurseries for 3 years, TLA was signed for commercialization of "VL White Grub Beetle Trap- 1" with S.S.K. Traders/Manufacturers, Almora, Uttarakhand for 4 years, TLA was signed for commercialization of "VL Metallic Plough" with M/s Himalayan Hi-Tech Nurseries for 3 years.

Gene Bank/ Medium Term Storage (MTS) Module

In the MTS module of ICAR-VPKAS, Almora, presently 17,064 germplasm accessions of 25 crops have been maintained. The germplasm comprised land races, obsolete varieties, genetic stocks, promising breeding lines and seed of national & international nurseries. A total 259 germplasm accessions, comprising barley (25), oilseeds (106), rice (65), Maize (2), pulses (10), finger millet (15), buck wheat (36) were collected during 2020-21 from hill region of Uttarakhand for its characterization and further utilization in crop improvement programmes.



Share (%) of germplasm accession of different crops in the gene bank

Staff

The staff position of the Institute as on December 31, 2020 is given below:

Positions	Sanctioned	Filled	Vacant
RMP	01	-	01
Scientific	55	41	14
Technical	44	26	18
Administrative	24	18	06
Supporting	35	39	-04
Total	159	124	35

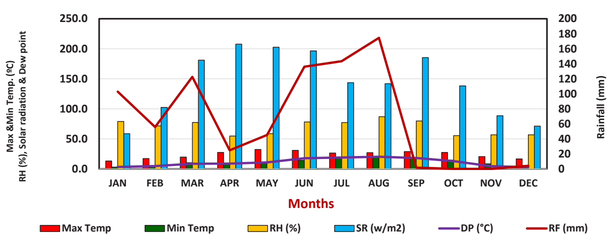
Finance

The budget outlay for March to December 2020 (Rs. in lakhs) is given hereunder:

Item	Allocation	Expenditure
Grant-in-General	410.00	307.60

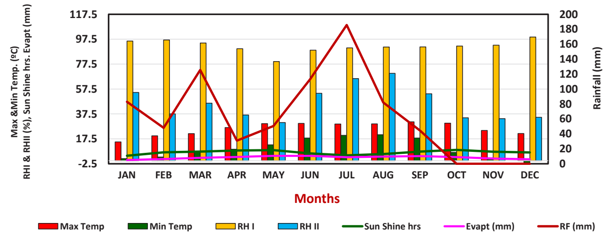
1.5 Weather and Crop Season

At Almora, the mean maximum daily temperature during *kharif* season (May to October) ranged from 26.4⁰C (July) to 32.2⁰C (May) and mean minimum daily temperature varied from 10.0⁰C (May) to 19.8⁰C (August). During *kharif* about 500.8 mm rainfall was received. The maximum rainfall was received during August (174.6 mm) followed by July (143.4 mm). The mean maximum daily temperature during *rabi* season (November to April) ranged from 13.1⁰C (January) to 27.5⁰C (April) and the mean minimum daily temperature from 2.9⁰C (January) to 10.3⁰C (March), respectively. During *rabi*, about 310.1 mm of rainfall was received, however the maximum rainfall was received during March (122.6 mm). The total rainfall for the entire year was 810.9 mm.



Meterological Data of ICAR-VPKAS, Almora

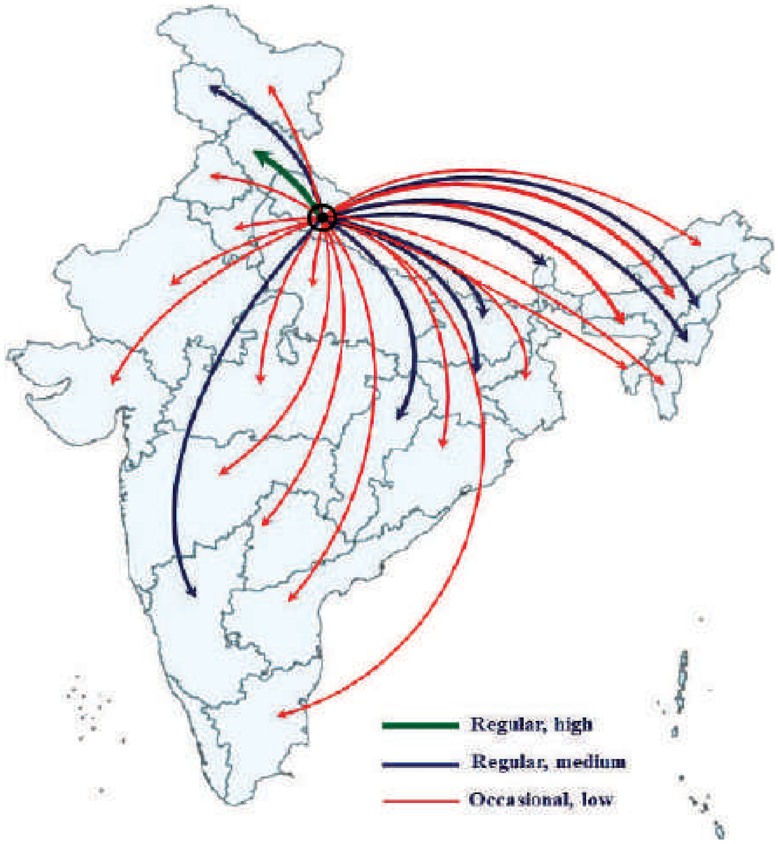
At the Experimental farm Hawalbag, the mean maximum daily temperature during *kharif* season (May to October) ranged from 29.4⁰C (July) to 31.2⁰C (September) and mean minimum daily temperature varied from 6.6⁰C (October) to 20.8⁰C (August). During *kharif* about 475.6 mm rainfall was received. The maximum rainfall was received during July (185.6 mm) followed by June (113.0 mm). The mean maximum daily temperature during *rabi* season (November to April) ranged from 15.1⁰C (January) to 26.6⁰C (April) and the mean minimum daily temperature from -2.1⁰C (December) to 9.2⁰C (April), respectively. During *rabi*, about 287.5 mm of rainfall was received. The total rainfall for the entire year was 763.1 mm.



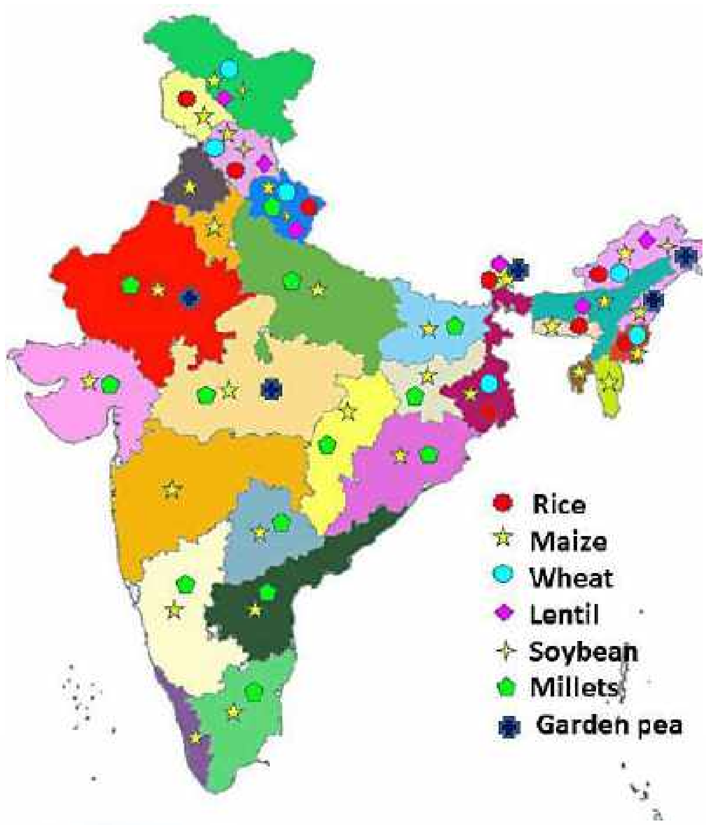
Meterological Data of ICAR-VPKAS Experimental farm, Hawalbag

Recommendation Domain of the Varieties Developed during Last Five Years Outside the Mandated Area

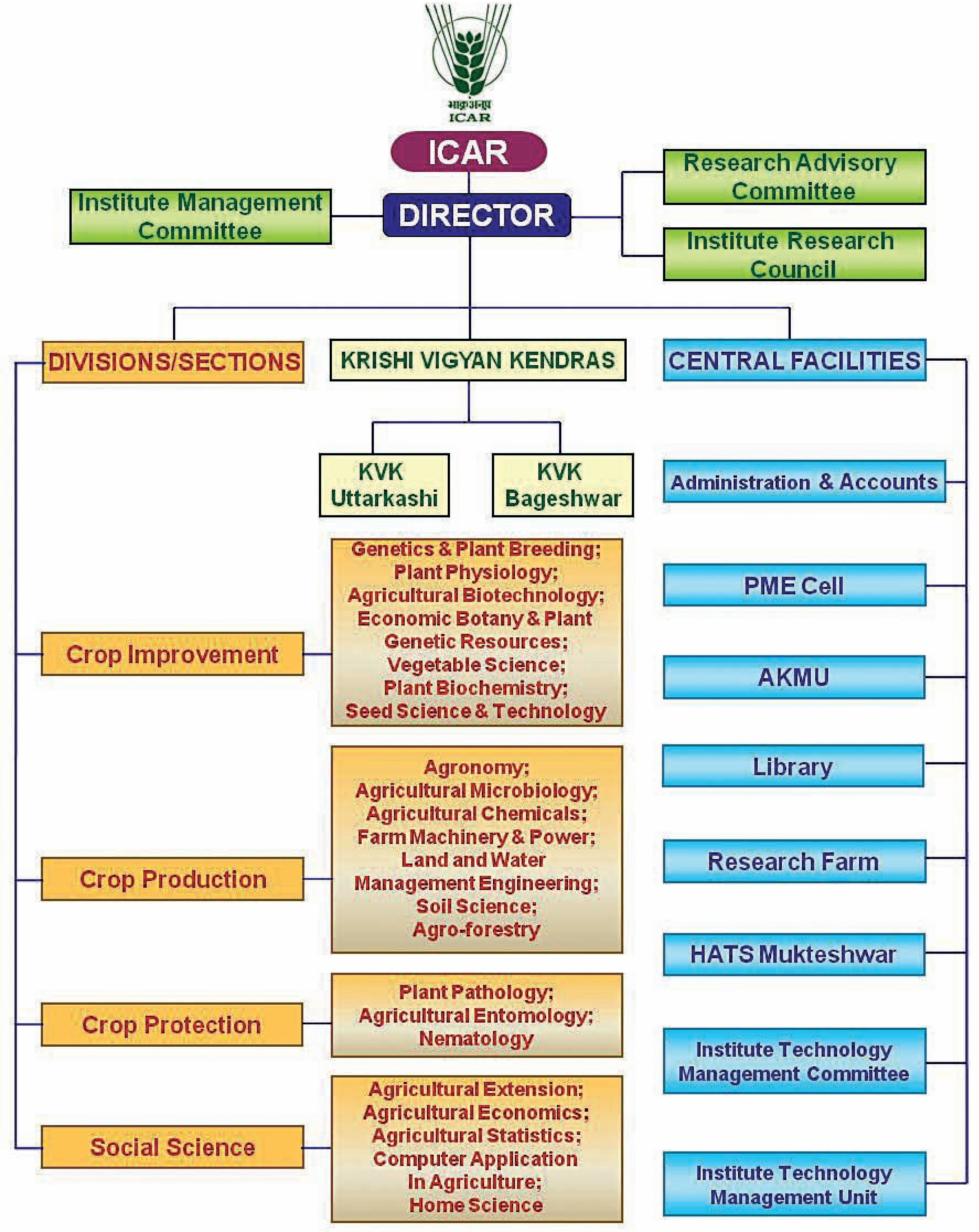
Since 2016, 22 improved varieties of various crops were developed. Among them, 10 were released through the Central Sub-Committee on Crop Standards, Notification and Release of Varieties and 12 were released through the Uttarakhand State Variety Release Committee. The recommendation domain of these varieties includes the states beyond the mandate area of institute as for example, western and southern states of the country, *viz.* Gujarat, Rajasthan, Chattisgarh, Madhya Pradesh, Punjab, Delhi, Haryana, Western Uttar Pradesh, Karnataka, Tamilnadu, Telengana, Andhra Pradesh, Maharashtra, Bihar, Jharkhand, Odisha and states of North-Eastern hill region. This indicates the strength of varietal improvement programme of the institute and success of well-planned strategies adopted by the scientists to develop widely adapted varieties for the entire hill region as well as various plain regions of the country. It also shows that the institute is marching towards a status of Centre of Excellence in varietal development for hills.



ICAR-VPKAS varieties seed reached in states of India



Technology Delivery Map of ICAR-VPKAS crops in states of India



Organizational Setup, ICAR-VPKAS, Almora, Uttarakhand

Field monitoring at Experimental farm, Hawalbag

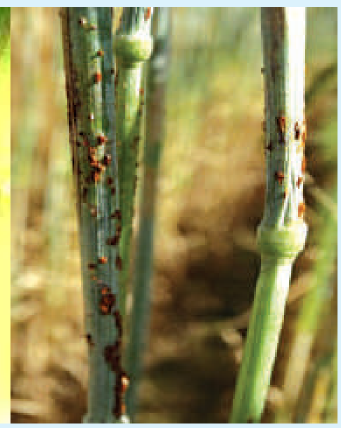
ACHIEVEMENTS

White grain VL *Mandua* 382

VL *Dhan* 210

VL *Chua* 110

Fall army worm



Wheat rust

Three row paddy transplanter

Solar drier

2. Enhancement in the Productivity of Major Hill Crops

Research Projects

- Genetic Enhancement of Maize for Yield and Nutritional Quality Using Integrated Breeding Approach *[Drs. R.K. Khulbe, Devender Sharma, Jeevan, B., R.S. Pal & D. Mahanta]*
  - **Sub Project** - Identification of Potential Lines and Hybrid Combination for High Fe and Zn Content in Maize through Biochemical and Molecular Approach *[Dr. Devender Sharma (PI)]*
- Enhancement of Genetic Potency of Rice for Productivity, Biotic and Abiotic Stresses for North West Himalayas *[Drs. J.P. Aditya, Rajashekara, H., Anuradha Bhartiya, Manoj Parihar (w.e.f., May 27, 2020) & Asha Kumari]*
- Genetic Improvement of Wheat and Barley for Higher Productivity, Quality Traits, Abiotic and Biotic Stresses *[Drs. L. Kant, Navin Chander Gahtyari, (on training w.e.f., February 3 to November 28, 2020) K.K. Mishra, D. Mahanta & Asha Kumari]*
  - **Sub Project** -Inheritance Studies for Transgenerational Stress Memory in Wheat Induced by Late Sowing [*Dr. Navin Chander Gahtyari (PI)] (on training w.e.f., February 3 to November 28, 2020)*
- Trait Mining and Genetic Improvement of Small Millets and Potential Crops in the Context of Climate Change *[Drs. D.C. Joshi, Rajashekara, H. & R.P. Meena]*
- Genetic Improvement of Pulses & Oilseeds for Higher Productivity, Quality, Biotic & Abiotic Stresses for North-Western Himalayan Hills *[Drs. Anuradha, Sher Singh, A.R.N.S. Subanna, J.P. Aditya, R.S. Pal & Jeevan B.]*
- Enhancement of Genetic Potency in Important Vegetables Crops for North Western Himalyan Ecosystem *[Drs. N.K. Hedau, Chaudhari Ganesh Vasudeo, Hanuman Chowdhary, K.K. Mishra B.M. Pandey, R.S. Pal & Hanuman Ram (upto August 7, 2020), Ashish Kumar & Amit Umesh Paschapur]*
  - **Sub Project:** Heterosis Breeding in Onion [*Dr. Chaudhari Ganesh V. (PI)]*
  - **Sub- project:** Capsicum Heterosis Breeding [*Dr. Chaudhari Ganesh V. (PI)]*
  - **Sub-project:** Collection Evaluation, Identification and Documentation of Underutilized Vegetable Crops for North-West Himalayan Ecosystem *[Dr. Rahul Dev (PI)]*
- Germplasm Evaluation in Major Hill Crops for Nutritional and Physiological Parameters Through Basic Techniques *[Drs. Ramesh Singh Pal, Anuradha Bhartiya, J.P. Aditya, Manoj Parihar, Devender Sharma, Navin Chander Gahtyari (on training w.e.f., February 3 to November 28, 2020) Hanuman Ram (upto August 7, 2020) & Asha Kumari]*
  - **Sub-project:** Evaluation and Identification of Major Hill Crops of North-West Himalayas for Abiotic Stress Management. [*Dr. Asha Kumari (PI)*]
  - **Sub-project:** Identification and Utilization of Important Genes/Alleles/Markers in Hill Crops [*Dr. Rakesh Bhowmick (PI)]*
- Seed Production *[Drs. L. Kant, R.K. Khulbe & Chaudhari Ganesh Vasudeo]*

2. Enhancement of Productivity of Major Hill Crops

2.1. Maize

Maize is an important cereal crop of North-Western Himalayas. By and large, maize is cultivated during the *kharif* season under rainfed conditions in the North-Western hills. The states of Himachal Pradesh, Uttarakhand and union territories (Jammu- Kashmir and Ladakh) with a total area of 625 thousand hectare and production of 1,189 thousand tonnes account for 7.2 and 5.5% of the national area and production, respectively. The productivity is 1,902 kg/ha compared to national average of 2,509 kg/ha. Considering the short growing period and high cropping intensity in hills, emphasis was laid on the development of early and extra-early duration genotypes, which mature in 85-90 days in hills with high yield potential and resistance to prevailing diseases in general and turcicum leaf blight in particular. Thrust was also placed on the development of speciality corn like sweet corn, pop corn and baby corn varieties, in view of the commercial potential of speciality corn in the region.

2.1.1 Varietal Improvement

Variety Released

VL QPM Hybrid 59 (FQH 106) It is an early maturing (85-90 days in mid-hills) and high yielding single-cross mass derived Quality Protein Maize (QPM) hybrid released for cultivation in Uttarakhand hills. FQH 106 (3,327 kg/ha) exhibited yield superiority of 17% over *Vivek* QPM 9 (2,823 kg/ha) under organic condition in SVT during 2016-18. It exhibited high responsiveness to inorganic fertilizers and recorded optimal yield performance of 11,400 kg/ha at N:P:K dose of 150:60:60. It possesses a mean tryptophan, lysine and protein content of 0.77, 3.33 and 8.91%, respectively. FQH 106 has yellow, semi-flint and medium bold grains (avg. 1000-grain wt. 325 g). It exhibited moderate resistance against turcicum and maydis leaf blight.

2.1.1.1 Elite Lines under Maize Improvement Programme

During *kharif* 2020, a total of 206 entries were evaluated in State Varietal Trial (SVT) and Station Trials. The entries performing better than the checks in the trials are as follows:

Trial	Promising entries	Best Check
State Varietal Trial (Hills)	FH 3879 (7,464 kg/ha) FQH 140 (6,251 kg/ha) FQH 148 (6,651 kg/ha) FQH 165 (7,230 kg/ha)	VMH 45 (6,488 kg/ha) Vivek QPM 9 (5,976 kg/ha)
Station Trials		
Normal Corn-I	FH 3983 (10,353 kg/ha) FH 3981 (10,294 kg/ha) FH 3970 (9,716 kg/ha)	Bio 605 (9,898 kg/ha)
Normal Corn-II	FH 4036 (9,980 kg/ha) FH 4032 (9,953 kg/ha) FH 4056 (9,467 kg/ha) FH 4045 (9,381 kg/ha)	Bio 605 (8,471 kg/ha)
Normal Corn-III	FH 3990 (11,093 kg/ha) FH 4016 (10,756 kg/ha) FH 3992 (10,251 kg/ha) FH 3993 (9,726 kg/ha)	DKC7074 (9,314 kg/ha)
Normal Corn-IV	FH 4000 (12,997 kg/ha) FH 4001 (12,600 kg/ha) FH 4003 (12,549 kg/ha)	VMH 45 (11,374 kg/ha)
Sweet Corn	FSCH 194 (18,869 kg/ha) FSCH 196 (18,778 kg/ha)	Misthi (17,880 kg/ha)

Iron-Zinc	FMH 18 (9,893 kg/ha) FMH 24 (8,915 kg/ha)	VMH 45 (9,495 kg/ha)
Inbred	V 400 (7,194 kg/ha) PVE-44-11 (7,097 kg/ha) VQL 398 (6,358 kg/ha) CQE (5,842 kg/ha)	V 373 (6,261 kg/ha)
CRP Biofortification / Molecular Breeding		
Biofortification	FPVH 15 (11,502 kg/ha) FQH 195 (11,370 kg/ha)	VMH 53 (10,973 kg/ha)

2.1.1.2 Breeding Materials/Development of New Strains

Development of composites

***Kwanu local*:** For developing a medium duration composite variety, inter-mating among selected individuals was initiated in local cultivar Kwanu local. The C_o population comprised of individuals of longer cobs (27-30 cm), higher number of kernel rows (>18) and highest test-weight (375-400 g). Ears were harvested from selected plants and screened for desired ear and seed traits. The seed from the selected ears was bulked for further cycles of inter-mating and selection.

Development of normal and specialty corn inbred lines

- Four hundred and thirty-five progenies of different homozygosity levels (74 S_1, 52 S_2, 37 S_3, 59 S_4, 120 S_5, 24 S_6, 43 S_7 and 26 advance generation lines) were evaluated and 402 (84 S_2, 72 S_3, 51 S_4, 65 S_5, 82 S_6, 14 S_7 and 34 advance lines) possessing earliness (90-100 days), medium plant height (150-175 cm), good vigour, shorter Anthesis-Silking Interval (ASI) (1-2 days) and tolerance to turcicum leaf blight (disease score <2.75) were retained for further selection and inbreeding.
- Sixteen advance generation elite inbred lines (V 517, V 518, V 519, V 520, V 521, V 522, V 523, V 524, V 525, V 526, V 527, V 528, V 529, V 530, V 531 and V 532) possessing early maturity (52-56 days to 50% silking), short stature (140-170 cm), high vigour and resistance to turcicum leaf blight (disease score <2.75) were established and used for hybrid development.
- To develop short duration and high yielding sweet corn lines, inbreeding was initiated in five promising open-pollinated populations identified during *kharif* 2020. Ten progenies possessing early maturity (53-58 days to 50% silking), medium plant height (180-220 cm) and tolerance to turcicum leaf blight (disease score <2.75) and banded leaf & sheath blight (disease score <2.5) were retained for further inbreeding and selection.
- Selection and inbreeding were continued in 13 S_1 progenies and 21 S_2 progenies of sweet corn and individuals with medium plant height (180-220 cm), earliness (52-57 days to 50% silking) and tolerance to turcicum leaf blight (disease score <2.75) were retained for further inbreeding, selection and use in hybridization.
- Evaluation of 20 BC_2F_2 progenies each of the crosses between normal corn lines V 412, V 461, V 467 and V 484 and sweet corn donors SA-14-1 and SB-4-1 was carried out. In each cross, 8-10 individuals with early maturity (54-58 days to 50% silking), shorter plant height (165-190 cm), shorter ASI (1-2 days) and tolerance to TLB (disease score <2.75) were retained for further inbreeding, selection and use in hybridization.
- Advances stage progenies of the crosses between elite normal corn lines (V 390, V 400 and V 407) and sweet corn lines (DMSC 36, EC 619310 and EC 619340, respectively) were evaluated and maintained. Seventeen progenies with shorter plant height (140-190 cm) and earliness (53-60 days to 50% silking) were developed and used in hybridization.

Development of new single-cross hybrids

- Seventy-five new normal corn hybrid combinations were generated involving 11 existing elite lines and 26 new promising lines (11 conventional inbreds and 15 DH lines) identified during *kharif* 2020.
- Thirty-five new sweet corn hybrid combinations

were generated involving 8 existing elite lines and 18 new promising lines identified during *kharif* 2020.

- Fifteen new biofortified (QPM and proA) hybrid combinations were also generated using elite VL lines and new promising lines.

Biofortification of maize for high Fe and Zn

- A set of 100 inbred lines were evaluated for Fe and Zn content though rapid screening (dye binding method) and biochemical estimation (AAS and ICP-OES). Depending on an estimated average requirement (EAR) of 1,460 µg/day for Fe and 1,860 µg/day for Zn by Harvest Plus, target levels were set at 52 and 33 µg/g for Fe and Zn, respectively.
- Twelve inbred lines {CS-15-2-1(V336 × VQL1), CS-16-2-1(V336 × VQL1), B73, VQL14, VQL16, CM152, CM153, V346, V390, V391, V496 and PA-12-1} were selected with >40 ppm Fe content. Ten inbred lines {(BS-21-2-3-1 (VQL2 × V336), CM127, CM212, V341, V400, V405, V407, BAJIM-06-6, CML189 and VLQC-11(1)} were selected with >33 ppm Zn content.
- Eight inbred lines (VQL5, BAJIM-06-11, BAJIM-06-14, BAJIM-06-15, BAJIM-06-17, CML161, Bhimtal Local and Champawat Local) possess >40 ppm Fe and >33 ppm Zn content. A set of 40 crosses involving (Fe × Fe), (Zn × Zn), (Fe × Zn) were generated at Winter Nursery Centre (WNC), Hyderabad.
- During *kharif* 2020, a set of 61 inbred lines for Fe and Zn content were evaluated and maintained. Twenty-nine inbred lines were retained with medium plant height (140-195 cm), earliness (52-58 days to 50% silking) and high micronutrient content.
- Thirty five new Fe/Zn hybrid combinations were generated involving using elite VL lines and new promising lines.

2.1.2. Germplasm Resource: Evaluation and Maintenance

- Forty-seven introductions from WNC, Hyderabad were evaluated and 29 introductions with early maturity (52-55 days) and tolerance to TLB (disease score <2.5) were retained for further inbreeding, selection and use in hybridization.
- Six local accessions of Uttarakhand (Kwanu Local, Dhiari Local, Amritpur Local, Champawat Local, Chamba Local and Jaunsar Local) were maintained.
- Two low phytate (Lpa 1, Lpa 2), 2 provitamin A (CIMMYT 4, CIMMYT 13), 2 liguleless lines and 3 haploid inducer lines were maintained.
- Seventeen biofortified (proA, QPM, low phytic acid) lines were evaluated and maintained.

2.1.3. Details of Germplasm Shared

The details of inbreds shared with various NARS institutes are as given below:

Details of maize inbreds shared with NARS institutes

Institute	Germplasm
Bihar Agricultural University (BAU) Sabour Bihar	VQL1
ICAR RC NEH Manipur	V373, V390, V412, V433
Division of Seed Science & Technology, ICAR-IARI, New Delhi	CM 212, CM145
DARS, SKUAST, Kashmir	V373, V390
Indian Institute of Maize Research, Ludhiana (for US)	V335, V345, V25, V341, V346, V351, V372, V373, V390, V405, V407, V409, CM145, CM152, CM153, CM212, VQL1, VQL2, V391
Indian Institute of Maize Research, Ludhiana (for SNP genotyping)	V372, CM127, CM129, CM141
ICAR-NBAIM, Mau (U.P.)	CM126, CM127, CM145, CM212, V341

2.1.4. Crop Protection Investigations

During *kharif* 2020, >400 maize entries from coordinated & station trials were evaluated for turcicum leaf blight (*Exserohilum turcicum*) disease under artificial inoculation conditions. Plants were inoculated with pathogen in central whorl after 30 days of sowing and allowed for symptom expression and disease development. Disease data were taken in a 1-9 scale.

Resistant sources for turcicum leaf blight

Trial	Resistant entries (<3 score)
QPM I-II-III	LQPMH 192, FLPH 19, QPMMH-41, VAMH 12014 (C), HQPM 29, HQPM 1 (C), QQMH 14191, DQH 113, IQPMH 2005, VMH 45 (C), DQH 112 and Pratap QPM Hybrid 1 (C)
Popcorn I-II-III	Bio 9544 (Filler) and VAMH 120 14 (C)
OPV	L316, L315, KDM-30, Hemant (C), SKMC-03 and VAMH 12014
Sweet Corn I-II-III	CMVL Sweet Corn 1, Misthi (C), FSCH 144 and BSCH 417160
Baby Corn I-II-III	DBCH-331, HM-4 (C), IMHSB-19KB-1, MBC-20-2, VL Babycorn-2 (C), IMHSB-20KB-3, VAMH 12014 (C) and IMHSB-19KB-2
Early entries	SMH 7439, H-120, DH-342, FH 3947, IU7514, JH 32487, KMH 19-86, KMH 18-13, DH-316, IAHM 2018-47, Bio 605 (C), JH 32479, EH 3531, IAHM 2018-49, LMH 2004, EH 3573, VAMH 12014 (C), FSMH-2001, DKC 7074 (C), LMH 2020, K 27, GMH 7108, LMH 2050, Vivek Hybrid 45 (C), FH 3941, LMH 2033, DH-338 and GK 3301
DH lines	45-DH-3, 45-DH-14, 45-DH-21, 45-DH-24, 45-DH-51, 45-DH-62 and 45-DH-19-2

2.1.5. Agronomic Investigations

Performance of pre-released early maturity maize genotypes under varying planting density and nutrient levels

Three early maturity maize genotype (FCE-20K-I-01, FCE-20K-I-02 and FCE-20K-I-03) were evaluated with two planting densities (60 cm × 20 cm and 60 cm × 16 cm) and two fertilizer levels (150-60-60 and 225-90-90 kg/ha N-P_2O_5-K_2O). Among genotypes, FCE-20K-I-03 produced (12,639 kg/ha) significantly higher grain yield than the rest of the genotypes. The fertilizer level of 225-90-90 kg/ha N-P_2O_5-K_2O provided significantly higher (10%) grain yield compared to 150-60-60 kg/ha N-P_2O_5-K_2O (10,791 kg/ha). The planting density of 60 cm × 16 cm (12,131 kg/ha) provided 15% more grain yield than 60 cm × 20 cm (10,565 kg/ha).

Relative performance of pre-released maize genotypes at different nutrient levels

Three new maize genotype (FQH 140, FQH 148 and FQH 165) were evaluated against two checks (VQPM 9 and VMH 45) with two fertilizer levels (150-60-60 and 225-90-90 kg/ha N-P_2O_5-K_2O). Among genotypes, FQH 148 produced (10,586 kg/ha) significantly higher grain yield than the rest of the genotypes, except FQH 140 (9,927 kg/ha) and VMH 45 (9, 867 kg/ha). The fertilizer level of 225-90-90 kg/ha N-P_2O_5-K_2O provided significantly higher (18%) grain yield (10, 415 kg/ha) compared to 150-60-60 kg/ha N-P_2O_5-K_2O (8,790 kg/ha).

2.2. Rice

In North-Western Himalayan hills, rice is a major *kharif* crop grown in 0.59 million hectares with production of about 1.34 million tonnes and productivity 2,286 kg/ha. The highest area of rice is covered by Jammu & Kashmir (0.26 m ha), whereas highest production (0.61 mt) and productivity (2,412 kg/ha) are found in Uttarakhand. In North-Eastern Himalayan States *viz.*, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizorum, Nagaland, Sikkim and Tripura the annual rice production is around 7.29 million tonnes from an area of about 3.44 million hectares with average productivity 2,125 kg/ha during 2018-19. The average productivity of rice in NW and NE Himalayan states is far behind than national average productivity.

2.2.1. Varietal Improvement

2.2.1.1 Varieties Released

VL *Dhan* 210 (VL 11364): It was developed from cross VLD 207/ VL 30424 and released by Uttarakhand State Variety Release Committee for rainfed upland spring sown rice under organic conditions of Uttarakhand. The average grain yield of 2,157 kg/ha was observed, which was 37.6% higher than the best check VL *Dhan* 207 (1,569 kg/ha). It has long slender grain with plant height 90-110 cm and resistant to leaf and neck blast.

VL *Dhan* 211 (VL 11574): It was developed from a cross between VL *Dhan* 209 and VL 30424 and released by Uttarakhand State Variety Release Committee for rainfed upland spring sown rice under organic conditions of Uttarakhand. On the basis of three years of testing, it has exhibited yield potential of 2,088 kg/ha. It has recorded yield advantage of 33.2% over the best check VL *Dhan* 207. It has short bold grains and resistant to leaf and neck blast.

VL *Dhan* 159 (VL 20083): It was developed from a cross between VL 66/HPR 2143. It has been released by Uttarakhand State Variety Release Committee for rainfed upland June sown organic conditions of Uttarakhand hills. It has yield potential of 1,964 kg/ha and recorded 21.7% yield superiority over the best check VL *Dhan* 221. It has long bold grain with plant height 95-100 cm and maturity 100-115 days. It has resistance against leaf and neck blast, brown leaf spot, sheath rot, false smut, leaf scald, stem borer and leaf.

2.2.1.2 Elite Lines under All India Coordinated Rice Improvement Programme

In irrigated early duration trial AVT-1E (H) 25 entries were evaluated including 3 checks and highest yield (5,444 kg/ha) was recorded for entry no 2404 whereas, entry no. 2423 (1,042 kg/ha) was found to be the lowest yielder. Likewise, in AVT-1M (H) comprising 13 entries including 3 checks recorded highest yield (5,419 kg/ha) in entry no. 2404 whereas, entry no. 2423 (1,042 kg/ha) was found to be the lowest yielder. In IVT-E (H) comprising 25 entries including checks highest yield (5,414 kg/ha) was recorded for entry no. 2511 whereas entry no. 2618 (1,232kg/ha) was found to be the lowest yielder. In trial IVT-M (H) 22 entries including checks were evaluated and entry no. 2620 obtained the highest yield (5,433 kg/ha) whereas, lowest yield (1,232 kg/ha) was reported in entry no. 2618.

2.2.1.3 Elite Lines under State Rice Improvement Programme

In Rainfed Upland June sown trial 6 test entries including two checks Vivek *Dhan* 154 and VL *Dhan* 156 were evaluated and the highest grain yield (1,527kg/ha) recorded in entry no. 20614. In SVT Irrigated transplanted early trial, 9 entries were evaluated including 3 checks Vivek *Dhan* 82, VL *Dhan* 85 and Govind. The mean grain yield of this trial was 2,914 kg/ha which ranged from 2,364 kg/ha (Entry no EPH 1007) to 3,444 kg/ha (Entry no EPH 1002 & EPH 1006). In SVT irrigated transplanted medium duration trial 9 entries were evaluated including 2 checks Vivek *Dhan* 62 and Pant *Dhan* 26. The mean grain yield in this trial was 2,949 kg/ha which ranged from 2,446 kg/ha (Entry no MPH 1109) to 3,642 kg/ha (Entry no MPH 1106).

2.2.1.4. Breeding Materials/Development of New Strains

A total of five station trials, *viz.* 2 initial and 3 Advance Station Trials were conducted at the institute in June sown rainfed upland and irrigated rice where fixed breeding lines were evaluated, compared with recently released variety as checks. Based on grain yield, resistance to major diseases like blast and brown spot aptly elite lines were identified. The elite lines selected from advance station trials were VL 32699 (5,225 kg/ha) and VL 32651 (5,167 kg/ha) in irrigated early duration as compare to the best check VL *Dhan* 86 (4,625 kg/ha); VL 32606 (5,629 kg/ha) and VL 32605 (5,513 kg/ha) in irrigated medium duration conditions as compare to the best check VL *Dhan* 68 (4,833 kg/ha), whereas VL 20725 (2,581 kg/ha) and VL 20818 (2,467 kg/ha) in rainfed upland June sown as compare to best check VL *Dhan* 157 (2,167 kg/ha). The desirable plant height <110 cm and maturity early (100-120 days in irrigated & rainfed upland June sown) and medium (125-140 days in irrigated) along with resistance against major diseases blast (1-3 score), brown spot (1-5 score) exhibited by these elite lines.

Segregating Breeding Materials

Based on desirable agro-morphological traits like earliness (100-120 days) and medium duration (121-140 days) maturity, semi dwarf (irrigated <110 cm, upland <90 cm) to intermediate (irrigated 110-130 cm, upland 90-125 cm) plant height, drought tolerance (0-3 score of leaf drying), diseases (0-5 score) and insects resistance (0-3 score) total 2,791 progenies derived from 460 crosses were selected in F_2 to F_5 generations under rainfed upland and irrigated transplanted ecosystem (Fig. 2.2.1.).

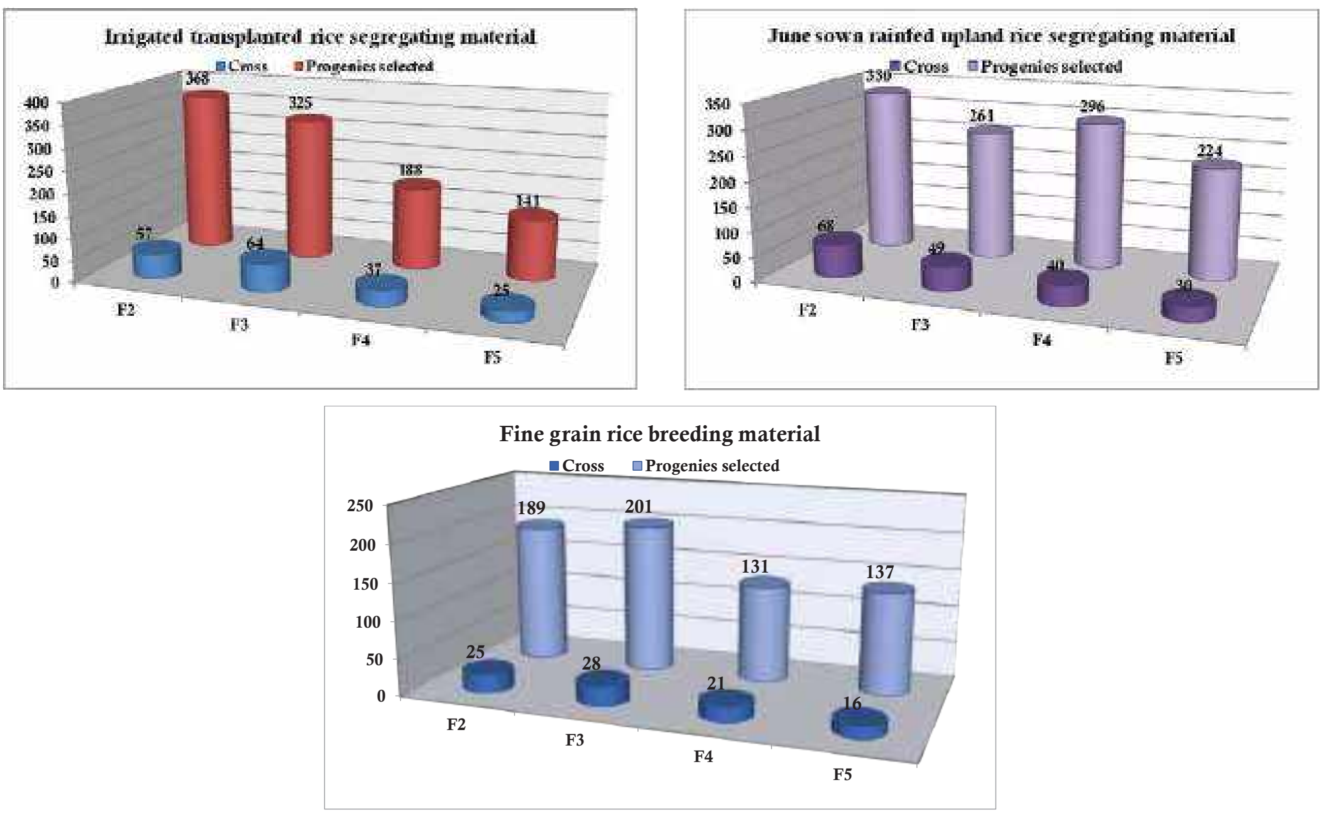


Fig. 2.2.1. Details of breeding materials under rainfed and irrigated ecosystem

2.2.2. Crop Protection Investigations

During *Kharif* 2020, different rice entries from station and coordinated trials were evaluated for leaf blast, neck blast and brown leaf spot diseases under natural conditions. The blast disease was evaluated under Uniform Blast Nursery (UBN) and brown leaf spot screening was performed in sick plots (Table 2.2.1.).

Table 2.2.1. Promising lines identified for brown leaf spot and blast disease of rice

Trial/Nursery	No of Entries	Promising lines identified (1 Score)		
		Brown leaf spot	Leaf blast	Neck blast
Advance station trial for June sown rainfed condition	18	None	None	VL 20808, VL 20810, VL 20811, VL 20814, VL 20816 and VL 20818
Advance station trial for transplanted rice	22	None	None	VL 32637, VL 32650, VL *Dhan* 86, VL 32652, VL 32678, VL 32699, VL 32722, VL 32606, VL 32622, VL *Dhan* 68, VL 32635, VL 32654, VL 32726 and VL 32732
VL rice blast screening nursery (VLRBSN)	84	--	VL 31674, VL 31802, VL 31997, A 57, C101 PKT, GSR-132, GSR-142 and *Oryza minuta*	VL 8394, VL 8654, VL 8657, VL 20279, VL 31451, VL 31598, VL 31615, VL 31616, VL 31619, VL 31674, VL 31679, VL 31817, VL 31870, VL 31997, VL 32131, RIL 10, GSR- 102, GSR-106, GSR-124, GSR-125, GSR-132, Dular, *Oryza minuta,* IRBLA-A, IRBLta-CP1, IRBL5-M, IRBLsh-B, IRBL1-F5, IRR-BL-150/2 and BAU/IRIR-497
National Screening Nursery for hills (NSNH)	128	CH 45 (3 score)	2304, 2512, 2413, 2419, 2612, 2617, 2620 and 2808	2301, 2310, 2508, 2509, 2407, 2413, 2606, 2609, 2621 and RP-BIO-226
National Hybrid Screening Nursery (NHSN)	105	3001, 3003, 3006, 3007, 3020, 3105, 3303, 3304, 3305, 3306, 3308, 3309, 3313, CH 45 and Rasi with 3 score	None	None
Donor Screening Nursery (DSN)	150	JGL 35085, IBT-GM-17, IBT-GM-39, HWR-1, HWR-6, HWR-31, HWR-32, HWR-33, ISMB-15, CB 16672, CB 16629, Swarnadhan and CH-45 with 3 score	None	--
National Screening Nursery (NSN-1)	323	--	None	--
National Screening Nursery (NSN-2)	557	--	None	--

2.2.3. Agronomic Investigations

Nutrient response trials of selected AVT-2 rice genotypes under optimum and low input management

In the AVT-2 Early Hill (EH), two new genotypes (IET 27472 and IET 27471) were evaluated against three checks (Shalimar rice 3, VL *Dhan* 86 and VL *Dhan* 85) under two fertility levels (low input 50% RDF and medium input 100% RDF). IET 27471 produced highest mean grain yield under both low (4.75 t/ha) and medium input (5.12 t/ha) which provided ~9% higher yield than the best check (Fig. 2.2.2).

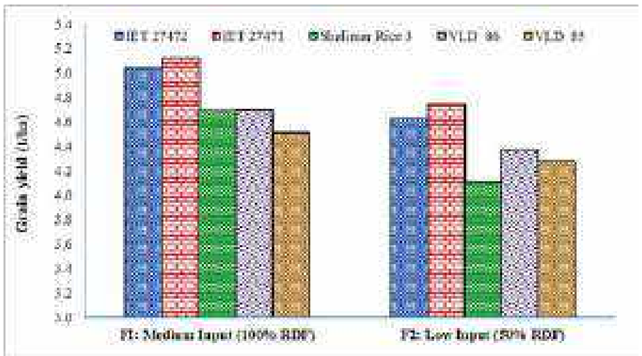


Fig. 2.2.2. Effect of nutrients level on grain yield of different early hill rice cultivars under transplanted condition

In the AVT-2 Medium Hill (MH), two new genotypes (IET 26594 and IET 26596) were evaluated against three checks (VL *Dhan* 62, VL *Dhan* 65 and VL *Dhan* 61) under two fertility levels (low input 50% RDF and medium input 100% RDF). Results showed that the grain yield of different rice genotype increased with increasing nutrient levels. IET 26596 provided highest grain yield under both low (4.42 t/ha) and medium (4.89 t/ha) inputs followed by IET 26594 and VL *Dhan* 65 and lowest in VL *Dhan* 61 (Fig. 2.2.3.).

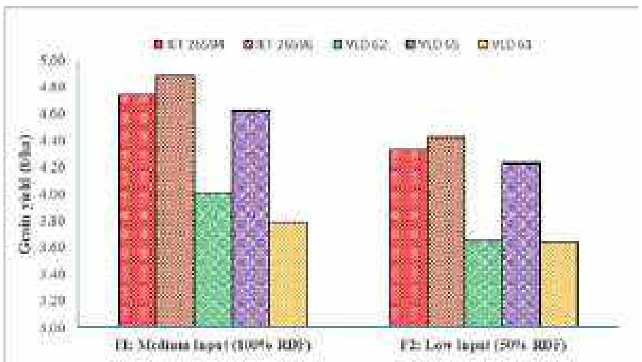


Fig. 2.2.3. Effect of nutrients level on grain yield of different medium hill rice cultivars under transplanted condition

In the AVT-2 Upland (UH), one new genotype (IET 27504) was evaluated against Bhalum 1,

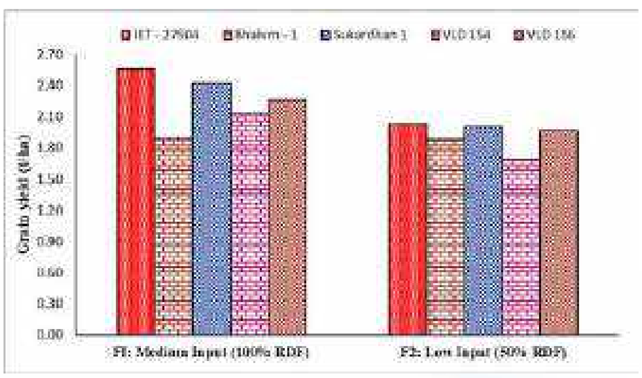


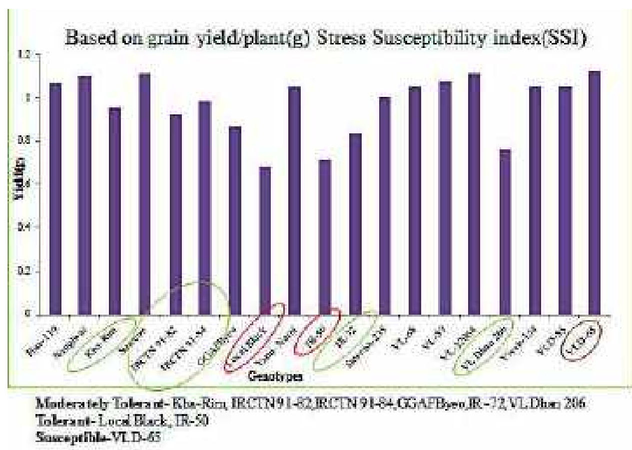
Fig. 2.2.4. Effect of nutrients level on grain yield of different upland rice cultivars

Sukardhan 1, VL *Dhan* 154 and VL *Dhan* 156 under two fertility levels (low input 50% RDF and medium input 100% RDF). The mean maximum grain yield of 2.03 and 2.56 t/ha was recorded for low and medium input, respectively with IET 27504 (Fig. 2.2.4).

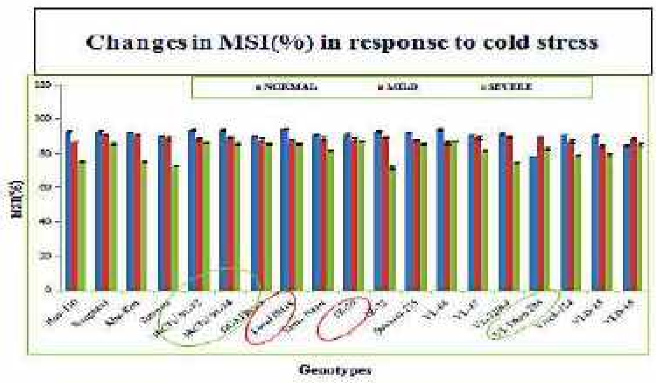
2.2.4. Physiological Investigation

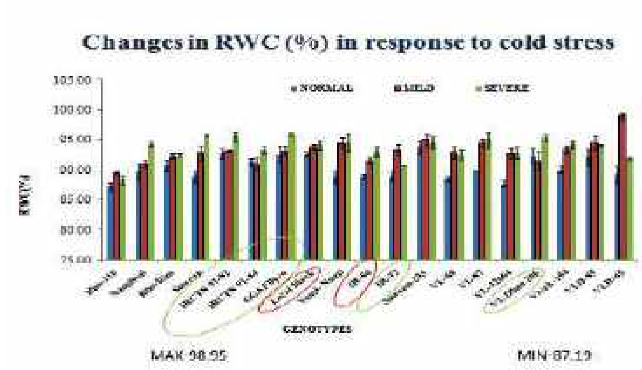
Biochemical study for important physiological and yield traits in rice in relation to cold tolerance

Leaf samples (171) of rice were collected at flowering stage for determining biochemical parameters (relative water content, membrane stability Index and stress susceptibility index) in rice crop. To better characterize the stress effect, stress susceptibility index (SSI) was calculated using total grain yield. To better characterize the stress effect, stress susceptibility index (SSI) was calculated as SSI = [1 − (Ys/Yt)/(1 − Xs/Xt)], where Ys: grain yield under stress, Yt: grain yield under non-stress, Xs and Xt being the mean of grain yields under stress and non-stress conditions, respectively and categorised as (>0.5- highly tolerant; 0.5-0.75- tolerant; 0.75-1.00- moderately tolerant and >1.00- susceptible.)



Both Relative Water Content (RWC) (%) and Membrane Stability Index (MSI) (%) should be taken as important physiological traits in determining cold tolerance in rice. As Stress Susceptibility Index (SSI) showed similar trend and depicts that local black and IR-50 are tolerant and Kba0-Rim, IRCTN 91-82, IRCTN 91-84, GGAF Byeo, IR-72, and VL *Dhan* 206 were moderately tolerant, whereas VL *Dhan* 65 was found susceptible.





2.3. Wheat

Wheat is the most important cereal crop of *rabi* season in N-W Himalayas. It is grown over an area of 0.95 million ha with an average productivity of 1,774; 1,628 and 2,749 kg/ha in the states of Himachal Pradesh, Jammu & Kashmir and Uttarakhand, respectively. The average productivity of the Zone is 2,050 kg/ha, much below the national productivity of 3,368 kg/ha in 2017-18. However, these levels of production and productivity can be raised if high yielding varieties having resistance/ tolerance to biotic (yellow, brown rust and loose smut) and abiotic (drought and cold) stresses are adopted along with suitable production and protection technologies.

2.3.1. Varietal Improvement

2.3.1.1. Variety Released

VL *Gehun* 2015: This high yielding genotype was developed from direct selection from a 4TH SRR DSBWYT-40 (Sale 6). It was notified for cultivation under timely sown rainfed organic conditions of Uttarakhand hills. It has an average yield potential of 1,988 kg/ha, which was 23.48% higher than the best check VL *Gehun* 907 (1,610 kg/ha) over three years of testing in Uttarakhand hills. Besides high yield, VL *Gehun* 2015 possesses high degree of resistance to yellow and brown rust under both natural as well as artificial conditions.

VL *Gehun* 2015

2.3.1.2. Elite Lines under All India Coordinated Wheat Improvement Programme

The newly developed wheat strains were tested for their adaptability with respect to grain yield, disease resistance and other desirable attributes under the rainfed as well as irrigated timely sown and restricted irrigation late sown conditions in 9 yield evaluation trials.

Rainfed conditions

Six entries were tested in AVT timely sown trial. The test entry VL 2036 (4,620 kg/ha) was ranked first as compared to the best check HS 562 (4,180 kg/ha). In timely sown IVT trial 16 entries were tested and test entry VL 2041 (4,040 kg/ha) was the top yielder and significantly superior to the best check HS 562 (3,550 kg/ha). Eleven entries were evaluated in the late sown restricted irrigation AVT (pre-sown irrigation only) trial and entry, *viz*. HS 680 (4,330 kg/ha) yielded statistically at par with the best check, *viz*. VL *Gehun* 892 (4,150 kg/ha).

Irrigated conditions

Six entries were evaluated under AVT timely sown trial and test entry VL 2036 (5,390 kg/ha) was the top yielder followed by the best check HS 507 (5,180 kg/ha).

2.3.1.3. Elite Lines under State Wheat Improvement Programme

Rainfed organic conditions

Eleven entries were tested under SVT organic timely sown trial and UP 3062 (3,865 kg/ha) recorded significant yield advantage over the best check VL *Gehun* 907 (3,084 kg/ha).

Irrigated organic conditions

Eleven entries were evaluated under the irrigated SVT organic timely sown trial and none was found superior to the latest check variety VL *Gehun* 967 (4,404 kg/ha).

2.3.1.4. Elite Lines under Station Trials

Initial station yield evaluation trials, one trial each under rainfed timely sown, irrigated timely sown and restricted irrigation late sown conditions was conducted to assess the adaptability of new wheat strains with respect to grain yield and disease resistance. Under timely sown rainfed trial, 42 entries were tested and the test entry VW 1932 (5,000 kg/ha) was at par with the best check HS 562 (5,080 kg/ha). Seventeen entries were evaluated under the late sown restricted irrigation (pre-sown irrigation only) trial and VW 1947 (5,660 kg/ha), VW 1948 (5,220 kg/ha) and VW 1938 (5,090 kg/ ha) were significantly superior to the best check VL 892 (4,740 kg/ha). Forty-two entries were evaluated under irrigated timely sown trial and VW 1921(7,060 kg/ha), VW 1924 (6,730 kg/ha), VW 1911 (6,730 kg/ha) was significantly better in grain yield than the best check HS 562 (5,790 kg/ha).

Fifty-five new bulks were evaluated in different station trials under the rainfed as well as irrigated conditions and 7 promising strains entered in different All India Coordinated Trials of Northern Hills Zone.

Development of new strains/breeding materials

Development of high yielding disease resistant (yellow and brown rust and loose smut) genotypes suitable for rainfed and irrigated timely sown and restricted irrigation late sown conditions of northern hill zone are the major objectives of the programme. Two hundred and seventy-seven fresh crosses [69 spring x spring (S×S) and 208 winter × spring (W×S) wheat] including direct, back crosses and three-way crosses were successfully made by utilizing diverse donors of winter and spring wheats. One hundred eight-one better performing F_1 hybrids, consisting of 67 S×S and 114 W×S were identified for evaluation of 365 F_1 hybrids.

Bulk pedigree method was followed to handle the breeding materials. F_3 and F_5 generations were grown under low fertility and rainfed conditions. One hundred fifty-one F_2's (*i.e.*35 S×S and 116W×S) and 399 bulk progenies of 399 crosses (243 W×S and 156 S×S) in F_3 to F_5 generations and 792 single plant progenies (41 S×S) and (59 W×S) of 100 crosses in F_6 and subsequent generations were planted for evaluation and further selection. The infector rows were planted in and around the breeding materials and inoculated following syringe-inoculation method of rust inoculation, which was mixture of prevalent pathotypes received from IIWBR, RS Flowerdale, Shimla, H.P. The heavy rust infection facilitated the selection and on overall basis, 398 bulk and 496 individual plant progenies from F_3 generations onward were selected.

2.3.1.5. Breeding for Quality Wheat

In wheat high protein content, high micro-nutrients, good *chapati* and biscuit making quality *etc*. are some of the important desirable quality traits. Therefore,

Table 2.3.1. Promising F_6 bulks with desirable quality parameters

Sample No	Iron (category)	Protein (%)	Carbohydarte (%)	Fat (%)	Moisture (%)	Beta carotene (ppm)	Zeleny sedimentation value (ml)	Polyphenols (mg GAE/g)
1205	Medium	10.7	69.7	2.2	13.8	1.8	54.0	0.29
1025	Medium	11.2	69.7	2.4	13.8	1.8	60.0	0.32
1020	Medium	11.0	69.5	2.3	13.7	1.8	58.0	0.32
1382	Medium	10.8	70.6	2.1	13.8	1.8	50.0	0.31
1223	Medium	10.7	70.0	2.2	13.8	1.8	50.0	0.31
1224	High	10.6	71.1	2.1	13.8	1.7	40.0	0.28
1198	High	10.1	70.1	2.0	13.7	1.7	50.0	0.27
1116	Medium	10.6	69.2	2.2	13.8	1.8	54.0	0.31
1149	High	10.4	70.6	2.2	13.8	1.6	60.0	0.29
1026	High	11.4	68.6	2.4	13.7	1.7	56.0	0.31

efforts were made to incorporate these traits in future genotypes through hybridization with the proven donors. For protein percentage (>12.5%) 3 entries, *viz.* DBW 93, DBW 110 & VL 3019; for *chapatti* quality one entry, *viz*. VL 858; for biscuit quality one entry, *viz*. HS 490; for sedimentation value one entry, *viz*. DBW 173; and for high iron content (>40 ppm) three entries, *viz*. HD 2888, HI 1605 & VL 907 1105 were used as donors and crossed with well adapted genotypes. Thirty-nine F_1 crosses attempted during the previous season for quality (*rabi* 2018-19) were evaluated during *rabi* 2019-20. Additionally, 23 fresh crosses were attempted during rabi 2019-20. Quality analysis of 178 F_6 bulks derived from such crosses was completed. The quality parameters of promising F_6 bulks are given in Table 2.3.1.

2.3.1.6. Improvement of Spring Wheat through Introgression from Winter Wheat Gene Pool

Fifty winter and facultative wheat selected for their high grain yield, tillering, ear length, grain number per ear and disease resistance were planted in a crossing block at experimental farm, ICAR-VPKAS, Hawalbagh and crossed to spring wheats known for their high yield potential, disease resistance (rust resistance in particular) and adaptation to the major wheat-growing regions of the country. Three-way crosses were also attempted with the F_1 of the previous year by crossing them with the selected spring wheat. A total of 80 crosses were successfully made during *rabi* 2019-20.

In addition to this, 75 F_1s made during *rabi* 2018-19 were planted and 70 were retained for growing their F_3 generation during the next crop season. A total of 69 F_2's retained during last season (2018-19), were raised during *rabi* 2019-20 and finally, 52 F_2's was bulked.

The 52 F_2 bulks were shared with 19 cooperators in three major wheat growing zones (Northern Hills Zone, North Eastern Plain Zone, Central Zone and Penninsular Zone) of the country for evaluation and further selection for different biotic and abiotic stresses. The utilization report revealed that these materials were used from 33.1% at different cooperating centers and a total of 2084 plants were selected.

2.3.1.7. Genetic Resources - Evaluation and Maintenance

Two national nurseries comprising of 158 entries were evaluated. One entry for good agronomic base (HD 2967); 6 entries for resistance to 3 rusts (PBW 703, PBW 760, DBW 107, DBW 187, FLW16 and WH 1127); 3 entries for high yield (HI 1609, PBW 752, PBW 757); 2 entries for high tillering (AKAW 3717, DHTW 60), 3 entries for high test weight (DBW 39, AKAW4927, HI8751); 1 entry for high iron content (WH 1310); 1 entry for long ear length (BRW 3723); 1 entry for high grain number (MP 3382); 2 entries for KB resistance (KBRL -79-2, KBRL -82-2); 1 entry for sedimentation value (DBW 173); 1 entry for high protein content (DBW 93) and 1 entry for blast resistance (HD 3043) were selected from National Genetic Stock nursery (NGSN) for their use as a donor in hybridization programme. In Elite International Germplasm Nursery (EIGN), 8 genotypes were selected for evaluation and utilization for introduction.

Screening of wheat germplasm lines for agronomic, quality and disease resistance traits

A total of 650 entries from the institute gene bank were selected based on their uniqueness, collection details and relevance to hill agriculture. An augmented trial of 745 entries, including the selected 650 germplasm entries along with 5 checks repeated in 19 blocks were evaluated for various agronomic, quality and disease resistance traits during *rabi* 2019-20. The lines were scored for various agronomic traits *viz.* plant height (cm), days to maturity (days), no. of tillers/plant, spike length (mm), no. of spikeletes/spike, empty glume width (mm), top awn length (mm) and scored for stripe rust, leaf rust and powdery mildew diseases. Coefficient of variation exceeded 14% for all the agronomic traits except days to maturity, with highest variability recorded for empty glume width (CV – 62.1%) & no. of tillers/plant (CV-36.4%) indicating good amount of variation existing in the germplasm lines. A total of 148 lines (23.2%) for yellow rust and 115 lines (18.0%) for powdery mildew had nil and less than unity disease score, respectively. The Fe and Zn content estimated by a rapid dye binding method with Perl's Prussian Blue and Dithizone reagents, respectively found 139 (22.9%) and 376 (61.8%) entries having high iron and zinc content, respectively. Among them 77 (12.7%) entries were having high amount of both minerals, *viz*. Fe & Zn.

2.3.2. Crop Protection Investigations

More than one thousand eight hundred wheat and barley entries/lines under different coordinated and station nurseries/trials were screened under artificial epiphytotic conditions. These include Wheat Disease Monitoring Nursery (WDMN), SAARC nursery, Loose Smut Expression Nursery (LSEN), VL rust screening nursery, Powdery Mildew Screening Nursery (PMSN), hill bunt screening nursery, Elite Plant Pathological Screening Nursery (EPPSN), Multiple Disease Screening Nursery (MDSN), National Barley Disease Screening Nursery, Elite Barley Disease Screening Nursery and Initial Barley Disease Screening Nursery. Below given lines of wheat and barley were found promising.

Nursery	Promising lines (disease reaction)
WDMN	PBW752 (0), C 306 (0), HS 507 (TS), HPW 349 (TR), WL1562 (10S) against stripe rust; susceptible check-60S
SAARC	HD 2189 (10S), PBW 660 (0S), Chakwal 86 (5S) against stripe rust; Susceptible check (40S)
Loose Smut Expression Nursery (LSEN-coordinated)	HPW 468, WH 1021, HD 3059, WH 1124, HI 8713, HI 8811, HI 1621(0%); Sonalika (45.63%)
VL Loose Smut Expression Nursery	Out of 106 entries, 68 entries are immune (0%)
VL Rust Screening	VW 1803, VW 1804, 1807, 1809, 1810, 1813, 1814, 1815, 1818, 1820, 1822, 1824, 1832, 1844 (0S); Infector (60S)
Powdery Mildew Screening Nursery (PMSN)	YRC1 (1), ONS 27 (1), ONS 29 (1), PMC 1 (1), MDSN 15 (1), PBW 343 (c) (7)
Hill Bunt Screening Nursery Coordinated (HBSN)	VL 907 (6.3%), HPW 473 (8.5%), VL 3024 (5.6%); VL 892 (c) (48.7%)
Elite Plant Pathological Screening Nursery (EPPSN)	VL 3020, VL 3021, PBW 820 (for all rusts), HI 1628, PBW 550, DBW 303 (for stem & leaf), PBW 752, UP 3043 (for leaf & stripe), PBW 821, HI 8805, WHD 963 (for stem & stripe)
Multiple Disease Screening Nursery (MDSN)	PBW 800, PBW 763 (Resistant to all three rusts +LB+ KB+FS+FHB) HS 661 (Resistant to all three rusts +PM+FS+FHB)
National Barley Disease Screening Nursery (NBDSN)	Out of 129 entries, 61 entries were highly resistant (0S); Infector-80S
Initial Barley Disease Screening Nursery (IBDSN)	Out of 404 entries, 128 entries were highly resistant (0S); Infector-80S

Chemical management of powdery mildew

A total of four chemicals, *viz.* propiconazole 13.9% + difenoconazole 13.9 EC @ 0.10%, azoxystrobin 18.2% w/w + difenoconazole 11.4% w/wSC @ 0.10%, tebuconazole 50% + trifloxystrobin 25% WG @ 0.06% and propiconazole @ 0.10% were tested against powdery mildew of wheat whereas water sprayed plots were kept as control (Table 2.3.2.).

Table 2.3.2. Effect of different fungicides on powdery mildew of wheat

Treatment	Dose (%)	Powdery mildew score (0-9 scale)	Grain yield (q/ha)	Yield increased over check (%)
Propiconazole 13.9%+Difenoconazole 13.9 EC	0.10	3.0	30.57	25.91
Azoxystrobin 18.2% w/w+Difenoconazole 11.4% w/wSC	0.10	2.33	36.94	52.14
Tebuconazole 50% + Trifloxystrobin 25% WG	0.06	1.66	42.37	74.38
Propiconazole	0.10	2.33	35.71	47.07
Control (without chemicals)	----	5.0	24.28	--
CD at 5%		1.39		

Results revealed that the lowest average powdery mildew disease (1.66 score on 0-9 scale) was observed in plots sprayed with tebuconazole 50% + trifloxystrobin 25% WG @ 0.06% followed by spray of azoxystrobin 18.2% w/w+difenoconazole 11.4% w/w SC @ 0.10% and propiconazole @ 0.10% (2.33 score). The significantly higher grain yield was obtained in plots sprayed with tebuconazole 50% + trifloxystrobin 25% WG@ 0.06% (42.37Q/ha) which was 74.38% higher than control plot.

2.4. Barley

Barley is being cultivated to some of the traditional areas of North-Western Himalayan Hills. It has a coverage of 660.8 thousand ha with an average productivity of 2,695 kg/ha. In NHZ, it has an acreage of 45 thousand ha with productivity of 1,227 ka/ha which is quite low as compare to national average (2017-18). Barley improvement work is focused mainly on the development of high yielding and disease resistant varieties suitable for rainfed conditions of NW hills.

2.4.1. Varietal Improvement

2.4.1.1. Elite Lines in All India Coordinated/ State/Station Trials

Fifty-eight new barley strains were evaluated in 4 different trials, to identify high yielding disease resistant genotypes. In AVT timely sown rainfed trial two entries out of five, *viz.* VLB 165 (4,363 kg/ha) and VLB 169 (3,970 kg/ha) outperformed the best check VLB 118 (3,955 kg/ha) with the former having significant yield gain and ranked third among the 22 test entries (including checks). VLB 157 (2,299 kg/ha) and UPB 1078 (2,275 kg/ha) surpassed the best check VLB 118 (2,037 kg/ha) in SVT (organic) timely sown rainfed trial. Twenty-eight new bulks generated through institute breeding programme were evaluated in station trials under rainfed condition. Five promising strains having yield potential from 3,381 to 4,226 kg/ha were selected and nominated in to the All India Coordinated Trials of Northern Hill Zone.

Development of new strains

To develop high yielding disease resistant genotypes, 105 introduced materials were evaluated and 30 were selected based on their agronomic score, yielding ability and yellow rust resistance (<20S score) for their further evaluation during the ensuing season.

2.5. Small Millets & Potential Crops

Small millets and potential crops are an integral part of hill and tribal farming in drylands across the country. These traditional rainfed crops are grown in North-Western Himalayan region from time immemorial because of their ability to provide assured harvest even under harsh and stressed conditions. Small millets are cultivated in over 196.8 thousand ha in North-Western Himalayas with maximum area in Uttarakhand (175.0 thousand ha) and productivity ranging from 360 kg/ha (other small millets in J&K) to 1,380 kg/ha (finger millet in Uttarakhand). Development of short duration, high yielding and disease resistant varieties of small millets is the main activity of the research program.

2.5.1. Varietal Improvement

2.5.1.1. Varieties Released

Finger millet

VL *Mandua* 382: It is the first white grain finger millet variety released for rainfed organic conditions of Uttarakhand hills and suitable for processing industry. It has been developed from WR- 2 (white grain late maturing genotype, blast susceptible) x VL 201 (early maturing locally adapted genotype).VL *Mandua* 382 (1,198 kg/ha) was at par with the check VL *Mandua* 324 (1,197 kg/ha) and out yielded the check PRM-1 (1,163 kg/ha) by 3.0% in SVT trials. VL *Mandua* 382 has higher calcium (340 mg/100g) and protein content (8.8%) in comparison to the check VL *Mandua* 324 (294 mg/100g and 6.6% respectively). Being a white grain genotype, release of VL *Mandua* 382 will provide a new option to farmers growing brown finger millet varieties. This will have much preference than the brown seeded varieties, in turn higher consumer acceptability and fetch better price to the farmers.


VL *Mandua* 378: It has been released for the rainfed organic conditions of Uttarakhand hills. It was developed from a cross GEC- 440 (early maturing core collection germplasm line) x VL *Mandua* 149 (blast resistant finger millet variety). It recorded an average grain yield of 2,296 kg/ha under organic conditions, which was 33.2% higher than the best check VL *Mandua* 324. It has medium maturity (110-114 days). VL *Mandua* 378 has higher calcium (361 mg/100g) and iron (3.5 mg/100g) content than the check variety VL *Mandua* 324 (294 mg/100g and 2.8 mg/100g, respectively).


Grain amaranth

VL *Chua* 110: It has been released for the rainfed organic conditions of Uttarakhand hills. It has been developed from VL *Chua* 44 (high yielding grain amaranth variety from Uttarakhand) x GA 2 (high yielding grain amaranth genotype from Gujarat). VL *Chua* 110 (890 kg/ha) out-yielded the checks VL *Chua* 44 (690 kg/ha) and PRA-1 (598 kg/ha) by an impressive margin of 28.98 and 48.83%, respectively in SVT trials conducted under organic conditions over three years. VL *Chua* 110 has medium maturity (116 days). It has higher protein (14.27%), calcium


(221.5 mg/100g) and total antioxidant activity (25.88 Mm/g DW) than the check variety VL *Chua* 44 (12.60%, 187.4 mg/100g and 17.72 mM/g DW, respectively).

2.5.1.2. Varieties Identified

VL *Mandua* 391: It has been identified for release in the rainfed organic conditions of Uttarakhand hills. It recorded an average grain yield of 2,143 kg/ha under organic conditions which was 18.7% higher than the best check VL *Mandua* 324 (1,805 kg/ha). It has medium maturity (110-114 days).

Barnyard millet

VL *Madira* 254: It has been identified for release in the rainfed organic conditions of Uttarakhand hills. It recorded an average grain yield of 2,176 kg/ha under organic conditions which was 26.5% higher than the best check VL *Madira* 207 (1,720 kg/ha). It has maturity duration of (105-110 days)

2.5.1.3. Elite Lines under All India Coordinated Small Millets Improvement Programme

Finger millet

A total of 42 finger millet genotypes were evaluated for yield and yield contributing characters in two coordinated trials. In Initial Varietal Trial, 3017 (3,223 kg/ha) and GPU 96 (2,453 kg/ha) were the top-ranking entries. Similarly, in Advanced Varietal Trial (AVT) (early and medium duration), 1004 (3,134 kg/ha) and 1008 (2,996 kg/ha) recorded highest yield followed by 1011 (2,782 kg/ha) and local check VL *Mandua* 324 (2,570 kg/ha).

Barnyard millet

In barnyard millet Initial and Advanced Varietal Trial (BIAVT) comprising 17 entries were evaluated for yield and yield contributing traits. Entry 2009 recorded the highest grain yield (2,904 kg/ha) followed by 2003 (2,634 kg/ha) and 2001 (2,023 kg/ha).

2.5.1.3. Elite Lines under State Varietal Improvement Programme

Finger millet

In the State Varietal Trial (SVT) under organic conditions, MH 1305 (2,327 kg/ha), MH 1307 (2,109 kg/ha) and MH 1303 (2,021kg/ha) were found to be superior to check in terms of grain yield. Entry MH 1305 was found resistant to neck and finger blast disease and recorded the lesser mean score of neck blast (2.2%) and finger blast (3.0%) compared to check VL *Mandua* 352 [neck blast (5.0%) and finger blast (5.0%)].

Barnyard millet

In barnyard SVT trial, entry BY-1406 was top yielder (2,309 kg/ha) followed by BY-1403 (2,173 kg/ha). Entry BY-1406 was found resistant to grain smut disease and recorded the lesser mean score of grain smut (2.2%) as compared to check VL *Madira* 207 (5.6%).

2.5.2. Breeding Materials/Development of New Strains

Finger millet

Yield evaluation of superior bulks in station trial

During the rainy season 2020, 39 superior bulks identified in F_6 generation of different crosses were evaluated in Initial Station Trial (IST) for yield and yield attributing traits along with four checks GPU 45, GPU 67, PR 202 and VL *Mandua* 376). Entry VR-20-10 (3,354 kg/ha), VR 20-7 (3,124 kg/ha) and VR-19-9 (2,930 kg/ha) were superior to the best check VL *Mandua* 376 (2,574.5 kg/ha). These bulks were also evaluated for resistance to neck and finger blast disease under natural conditions. Entry VR-20-10 was found to be resistant to neck (mean score 1.8 %) and finger blast (mean score 2.7%), whereas VR-20-7 (13.2%) and VR-19-9 (11.8%) were moderately resistant to both the diseases.

Development of new strains

During *kharif* 2020, 32 new cross combinations were attempted involving high yielding blast resistant released varieties (VL *Mandua* 380, VL *Mandua* 378, VL *Mandua* 391 and PRM 1); early maturing, locally adapted lines (VL 396, VL 340, VL *Mandua* 347, VL *Mandua* 315 and VL *Mandua* 352); white grained lines (VL 384 and VR 13-18). In addition, local promising hill collections (VHC 3280, VHC 3310 and VHC 3410) as well as genotypes picked from yield evaluation trial (IVT 14, IVT 20 and IVT 2) were also included in crossing program.

The breeding materials were handled following pedigree method. Plant progenies of different segregating generations were subjected to rigorous selection. The infector rows for neck and finger blast were planted in and around the breeding materials. The detail of the breeding material and single plant selections (SPS) made are given in (Table 2.5.1.).

Table 2.5.1. Details of finger millet breeding material

Generation	Number of crosses	Number of progenies	Single plant selections	Plant selections criteria
F_1	22	-	-	Early maturity (100 days), resistance to blast, ear head shape, number of fingers and grain yield
F_2	22	-	53	
F_3	14	93	110	
F_4	27	238	50	
F_5	10	49	86	
F_6	4	38	52	

Barnyard millet

Yield evaluation of superior bulks in station trial

Twenty-five bulks identified from F_6 generation of different crosses were evaluated for yield and yield contributing traits in barnyard millet initial station trial along with two national checks (DHBM 93-3 and VL *Madira* 207) and one local check (PRJ 1). Entries VB 20-2 (2,916 kg/ha), VB 20-8 (2,728 kg/ha) and VB-20-6 (2,382 kg/ha) were superior to the best check VL Madira 207 (2,218 kg/ha).

Development of new strains and details of breeding material

During *kharif* 2020, 25 new cross combinations were attempted involving locally adapted genotypes (VB 18-13, VB 18-69, VB 19-3, VL 29, VB 18-8, VB 19-16, VB 18-2 and VL 137) and promising line from ICRISAT core collection lines (IEc 552, IEc 566, IEc 567 and IEc 489). The details of segregating breeding materials are presented in Table 2.5.2.

Table 2.5.2. Details of barnyard millet breeding material

Generation	Number of crosses	Number of progenies	Single plant selections	selection criteria
F_1	13	-	-	Early maturity (> 100 days), resistance to grain smut, panicle length and width, grain yield
F_2	11	-		
F_3	15	52	76	
F_4	8	75	45	
F_5	11	89	47	
F_6	12	53	-	

2.5.3. Crop Protection Investigations

Screening for disease resistance

During *Kharif* 2020, entries of both station and coordinated trial entries were evaluated for disease, resistance to blast and grain smut diseases, respectively. The resistant sources identified were summarized in Table 2.5.3.

Table 2.5.3. The most prominent genotypes identified based on one season data

Crop	Nurseries	Entries	Disease	Highly resistant entries (0-3 % incidence for neck and finger blast)
Finger millet	Station trial-2020	39	Leaf, neck and finger blast	VR-20-15, VR-20-18, VR-20-19 and GPU-67 for Neck blast and VR-20-33 for finger blast with moderately resistant for leaf blast
	Advanced Varietal Trial (North Zone)	13	Leaf, neck and finger blast	AVT-59, AVT-5, AVT-114 and AVT-6 with moderately resistant to leaf blast
	Initial Varietal Trial (IVT)	27	Leaf, neck and finger blast	IVT-110, IVT-8, IVT-53 IVT-57 and IVT-58 with moderately resistant to leaf blast
	National Screening Nursery (NSN-FM)	20	Leaf, neck and finger blast	NSNFM-27 and NSNFM-28 with moderately resistant to leaf blast
Barnyard millet	Station trial	25	Grain smut disease	VB-20-10, VB-20-10, VB-20-21, VB-19-18 and VB-19-16 with immune reaction (0 score)

2.6. Pulses & Oilseeds

Pulses and oilseeds are the inseparable part of rainfed agriculture in marginal lands across the country. These valuable crops traditionally serve as crucial component in native food culture, crop rotations and cropping systems in North-Western Himalayan region because of their ability to ensure food and nutritional security even under harsh and stressed agro-climatic conditions. Pulses are cultivated in 108 thousand hectares with 120 thousand tonnes production, whereas the total oilseed production is 89 thousand tonnes from 91 thousand hectares in North-Western Himalayas (DAC 2018-19). Development of nutritionally superior high yielding, disease and insect-pest resistant varieties suitable for hill agro-ecosystem with matching production technology are the thrust areas in research programme for improving pulses and oilseeds production in hills.

2.6.1. *Rabi* Legumes (Lentil and Field pea)

Varietal Improvement

2.6.1.1. Variety Notified

VL *Masoor* 148: This is a wilt and rust resistant high yielding lentil variety notified for NHZ comprising the states/union territroy of Uttarakhand, Himachal Pradesh, Jammu Kashmir and NE hills. It has been developed from a cross 'DPL 15/ L4076'. Its mean grain yield is 1,148 kg/ha. It has shown yield superiority of 18.3% over the best national check variety PL4. It matures in 147-163 days and moderately resistant against pod damage and aphids. It is nutritionally superior with 30.46% protein in its grains.

VL *Bhat* 202: This is a Frog eye Leaf Spot (FLS) resistant high yielding black soybean (*Bhat*) variety notified for cultivation in Uttarakhand. Its mean grain yield is 1,596 kg/ha. It has shown yield superiority of 35.95% over the best check variety VL Soya 65. It matures in 110-114 days and moderately resistant against pod damage and aphids. The specialty of this variety is its high protein (39.19%) and lesser grain weight (16.41g/100 seed), which is preferred in local cuisine of Uttarakhand.

VL *Matar* 61: Tall type field pea variety VL *Matar* 61 was notified for cultivation for timely sown rainfed condition of Uttarakhand hills. This high yielding (1,130 kg/ha) variety developed from a cross 'DDR 23/VL 1'. It has a yield superiority of 11.54% over the best check Pant Pea 14 and 16.37% over VL *Matar* 42, which are the national and state check for more than a decade. It matures in 152-156 days and moderately resistant against wilt, powdery mildew, aphid incidence, pod damage and leaf minor damage.

2.6.1.2. Elite Lines under All India Coordinated Programme

During *rabi* 2019-20 yield evaluation trials were conducted to assess the adaptability of new strains with respect to grain yield, disease resistance and other desirable attributes under the rainfed condition. Under lentil AICRP trials, the entry, *viz*. VL 533 (1,134 kg/ha) surpassed the best checks VL *Masoor* 507 (1,115 kg/ha) for IVT (large seed) whereas entry VL 159 (780 kg/ha) performed at per with the best check PL 4 (783 kg/ha) for IVT (small seed) with significant superiority. Similarly, in field pea AICRP trials, in IVT (Tall), none of the entry could surpass the best check HFP 9426 (1,662 kg/ha).

2.6.1.3. Elite Lines under State Varietal Trial (SVT)

In SVT, lentil entries VL 159, VL 152, VL 156, VL 533 and VL 527 were tested under organic mode but none of the entry could surpass the best check VL *Masoor* 133 (771 kg/ha). In SVT, field pea entries namely VL 70 (1,524 kg/ha) and VL 71 (1,398 kg/ha) were tested but none of the entry could surpass the best check VL *Matar* 42 (2,111 kg/ha).

2.6.1.4. Breeding Materials/Development of New Strains

During *rabi* 2019-20, 57 new cross combinations were obtained involving high yielding wilt resistant released varieties (PL 02, IPL 321, DPL 58, PL 117 & DKL 37); high biomass (LL 1203, LL 699 & LL 1122); earliness (ILWLS 118, L 4717 & L 4710) in the crossing program. Thirty-one cross combinations were advanced to F_2 generation whereas, different segregating generations were subjected to rigorous selection for traits, *viz*. yield components, biomass and wilt resistance and 198 crosses and 290 progenies (F_2 to F_6 generation) were selected and advanced to subsequent generations following pedigree method. Uniform bulks in both small (22) and large (19) seeded lentil were selected for further evaluation of yield, component traits, diseases, insect-pest reaction and quality characters.

In field pea, 33 new cross combinations were made involving 16 diverse parents with high grain yield (VL *Matar* 42, VL *Matar* 47, *Pant* pea 125), powdery mildew resistance (HFP 715, IPF 13-14, RFP 2009-2, *Pant* P 200 and RFPG 79) and semi leafless traits (HFP 4, *Aman* and VL *Matar* 47). Thirty-one F_1 crosses were advanced to F_2 generation. Segregating generations were subjected to rigorous selection for yield and desirable yield components like pods per plant, pods per cluster, seeds per pod, semi-leaflessness, disease and insect pest resistance and 144 crosses and 412 progenies were selected in F_2 to F_6 generations.

2.6.1.5. Crop Protection Investigations

Bruchids are considered as a serious storage pest of lentil. In view of this, a preliminary screening of 982 lentil germplasm alongwith checks, *viz.* VL *Masoor* 129, VL *Masoor* 133, VL *Masoor* 507 and VL *Masoor* 514 leads to identification of 14 entries with respect to adult emergence and grain weight loss. Further screening of these entries under field conditions, *viz.* artificial and contained release of bruchids against maturing plants showed no egg laying on developing pods on all the entries. Further screening of these entries under laboratory conditions led to identification of three resistant accessions (EC267620, EC139858 and EC78450) with minimal egg load (approx. 5 eggs per 30 seeds) and further adult emergence (approx. 3 adults per 30 seeds).

2.6.1.6. Agronomic Investigations

Response of lentil varieties to different fertility levels

In a study on response of lentil genotypes to fertility levels, among small seeded genotypes, VL *Masoor* 152 gave highest seed yield (1,074 kg/ha) while among bold seeded VL *Masoor* 527 gave highest seed yield (1,171 kg/ha). The seed yield increased with increasing fertility levels with 30:40:00 of N: P_2O_5: K_2O kg/ha producing highest seed yield (1,157 kg/ha). The bold seeded varieties performed better than small seeded varieties.

2.6.2. *Kharif* Legumes (Horsegram)

2.6.2.1. Elite Lines under All India Coordinated Programme/ SVT

Yield evaluation trials were conducted to assess the adaptability of new strains *viz.* VLG 51 & VLG 52 with respect to grain yield, disease resistance and other desirable attributes under the rainfed condition. In SVT VLG 52 (1,130 kg/ha) promoted to SVT-II year by surpassing the best check VLG 19 (984 kg/ha).

2.6.2.2. Elite Lines under Station Trials

During the *kharif* 2020, a total of 2 station trials were conducted comprising Initial Station Trials (40 entries) and Advance Station Trials (13 entries) of horsegram. In Initial Station Trial, entries, *viz.* VLG 2019-40 (833 kg/ha), VLG 2019-32 (803 kg/ha) and VLG 2019-33 (786 kg/ha) were found superior to the best check VL *Gahat* 15 (648 kg/ha). In Advance Station Trial entries, *viz.* VLG 2016-3 (972 kg/ha) and VLG 2016-10 (952 kg/ha) were found superior to best check VL *Gahat* 19 (819 kg/ha).

2.6.2.3. Breeding Materials/Development of New Strains

During *kharif* 2020, 12 diverse parents were selected on the basis of high yield (VLG 19, VLG 15, VLG 8 and VLG 10), anthracnose resistance (HPK 2, HPK 4 and VLG 19) and earliness (VLG 19 and AK 42) for hybridization programme. Involving these parents 47 new cross combinations were attempted. From F_2 to F_6 generation approx. 168 crosses and 267 progenies were selected for yield and component traits, diseases (anthracnose) resistance. Forty uniform bulks were selected from F_6 generation for their further evaluation in station trials.

2.6.3. Oilseed Crops – Soybean

2.6.3.1. Elite Lines under All India coordinated programme

A total of 187 soybean entries were evaluated for yield and yield contributing characters in three coordinated trials (IVT, AVT I, G x E Interaction Trial & Germplasm Evaluation trial). In IVT, entries with code 16 (1,722 kg/ha), code 7 (1,640 kg/ha) and code 26 (1,501 kg/ha) were the top performing entries. In AVT I entry VLS 99 (2,358 kg/ha) was found superior to the best check VL Soya 63 (1,850 kg/ha).

2.6.3.2. Elite Lines under Station Trials

During the *kharif* 2020, a total of 3 station trials were conducted comprising Initial Station Trial (21 entries), Advance Station Trial (16 entries) for soybean and Station Trial for Bhat (10 entries). In Initial Station Trial, entries, *viz.* VS 2019-4 (2,618 kg/ha), VS 2019-2 (2,451 kg/ha) and VS 2019-1 (2,313 kg/ha) were found superior to the best check VLS 59 (2,294 kg/ha). In Advance Station Trial entries, *viz.* VS 2016-1 (2,625 kg/ha), VS 2016-36 (2,269 kg/ha) and VS 2015-12 (2,358 kg/ha) were found superior to best check VLS 89 (2,082 kg/ha). In black soybean station trial, entries, *viz.* VB 2017-

103 (1,998 kg/ha), VB 2016-101 (1,924 kg/ha) and VB 2019-7 (1,801 kg/ha) were found superior to the best check VLB 201 (1,761 kg/ha).

Breeding materials/Development of New Strains

During *kharif* 2020, 24 diverse parents were selected on the basis of high yield (VLS 47, VLS 63, VLS 59, VLS 77, PS 1556, PS 1092, PK 416 and *Pusa* 22), frog eye leaf spot resistance (VLS 47, RSC-10-17 and Himso 1685), earliness (JS 95-60 and VLS 73) determinate plant type in *Bhat* (VLS 65, Birsa soya 1 and VLB 201), wild parent (*G. soja*), promising local collection (VRPH 1444 and Pauri Local) and germplasm (EC 34057) for hybridization programme. Involving these parents 40 new cross combinations were attempted. From F_2 to F_5 generation, 125 crosses and 280 progenies were selected for yield and component traits, diseases (frog eye leaf spot and pod blight) and insect-pests (*Chauliops* and defoliators) resistance. Thirty two uniform bulks were selected from F_6 generation for their further evaluation in station trials.

2.6.4. Crop Protection Investigation

During *kharif* 2020, major diseases observed at Hawalbagh (Almora) and farmers' field in Almora district were Frogeye leaf spot (FLS), bacterial pustules and pod blight (Ct). FLS appeared during second week of August. The severity increased in September and reached up to 77.7% infection index in few entries. Bacterial pustule (BP) and pod blight (PB Ct) were observed with low to moderate intensity.

In soybean trap nursery for disease monitoring, out of 16 entries evaluated against frog eye leaf spot (FLS) disease, based on the disease screening scores it was observed that the entries JS 95-60, MACS 58, VLS 58 and JS 335 showed resistant reaction (11.1% infection index). Out of 67 soybean entries previously found resistant against FLS, 51 entries maintained their resistance, however, none of the entries showed immune reaction (0 score on 0-9 scale). More than 100 soybean entries and 12 *bhat* entries of different station trails were evaluated for their reaction against FLS under natural epiphytotic condition. The resistant entries identified were given in the Table 2.6.1.

Table 2.6.1. Identified resistant sources in soybean and *bhat* entries for Frogeye Leaf Spot (FLS) disease

Trials	Highly resistant entries
Soybean Advance Station Trial	VS 2016-11, VS 2017-1, VS 2017-12, VS 2018-14 and VS 2018-6
Soybean AVT-1	VLS-99
Soybean Initial Station Trial	VS 2019-20
Bhat Advance Trial	VB2017-103, VB2016-104, VB 2019-4 and VLB-201

During *kharif* 2020, monitoring of different field trials for pest incidences was done under natural conditions at Hawalbag. During the season, low incidence of bihar hairy caterpillar, *Spilosoma obliqua*, leaf minor, *Platypria hystrix* and aphids was observed. The incidence of sucking bug, *Chauliops choprai* was started late in the season and was found to be low to medium in different trials. A total of 130 soybean entries under station trials were screened for incidence of *Chauliops* under field conditions. All of the entries including five checks showed incidence of pest at a range of 5-7 adults per leaf and were found to be susceptible except for one, PS1556 where 1.8 adults per leaf was observed. During *rabi* 2019-20 low incidence of leaf minors in field pea was observed. All the entries in advanced station trials (14 entries), SVT organic trial (12 entries) showed 2-5% incidences of leaf minor and were found to be resistant. However, in initial station trial, out of 32 entries, entries 12 and 25 showed only 1% incidence of pest and were found to be resistant.

2.6.5. Biochemical Investigations

Screening of soybean genotypes for low trypsin inhibitor

Forty-two genotypes of soybean were screened for low trypsin inhibitor and total protein. Maximum protein was found in EC 357999 (40.97%). Wide variations were observed for trypsin inhibitor activity (33.15 - 53.05 TIU/mg protein). Lowest trypsin inhibitor activity was found in EC 390978 (33.15 TIU/mg protein). Although no genotypes were found having trypsin inhibitor activity lower than the set threshold limit *i.e.* 30.00 TIU/mg protein

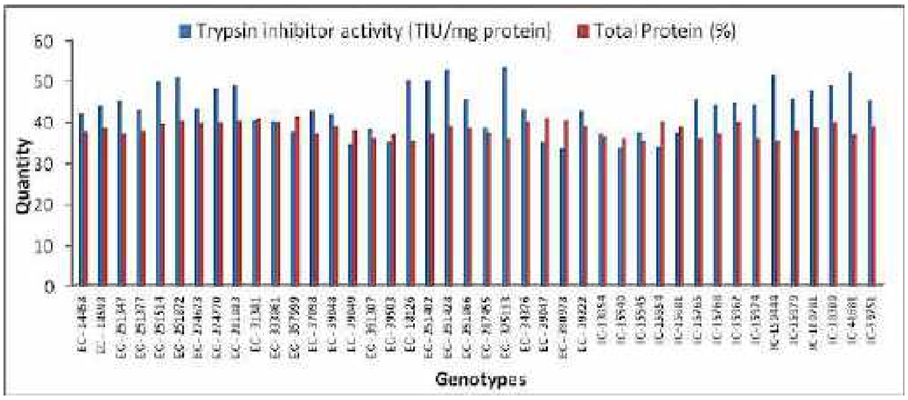


Fig. 2.6.1 Trypsin inhibitor activity of indigenous and exotic lines of soybean

2.7. Vegetable Crops

Vegetable cultivation, principally off-season and temperate ones are recognized as practicable and lucrative ventures, due to niche potentials of hills. The total area under vegetable cultivation in Uttarakhand is around 97.41 thousand ha with an average productivity of 10.35 t/ha, which is much below the national productivity of 18.52 t/ha (NHB 2019-20). Development of HYVs specific to quality, market demands and resistant to biotic stress along with package of practices is an important area of research activity for the improvement of vegetable scenario of North- Western Himalayas.

2.7.1. French bean

2.7.1. Varietal Improvement

Total 3 trials including Advance Station Trials (AST) and a State Varietal Trial (SVT) were conducted. A total 36 and 06 genotypes, respectively were evaluated for their green pod yield performance against checks, *viz. Pant Anupama*, *Arka Suvidha*, *Komal*, VL Bean 2 and *Arka Anoop* (*excluded for SVT*). Entry VLFB 1828 (10,835 kg/ha) recorded maximum green pod yield in AST, whereas entry VLFB 1707 (10,710 kg/ha) recorded maximum green pod yield in SVT.

2.7.1.1. Development of New Strains

Emphasis was given to develop genotypes with high yield, stringless pod, and resistance to rust. In this endeavour, 12 new F_1s were developed using diverse parents. Two hundred six progenies derived from 58 crosses were advanced in F_2 to F_8 generations. Seven new bulks were also made based on phenotypic uniformity in ensuing crop season.

2.7.2. Tomato

2.7.2.1. Varietal Improvement

Seven yield evaluation trials were conducted to evaluate 53 entries including suitable checks to identify high yielding genotype in determinate, indeterminate and cherry group. 2019/TODVAR-2 (14,858 kg/ha), 2018/TODVAR-1 (26,442 kg/ha), 2017/TODVAR-1 (15,038 kg/ha), 2018/TOINDVAR-6 (17,467 kg/ha), 2018/TOCVAR-6 (10,858 kg/ha), 2019/TODHYB-1 (18,660 kg/ha) & 2017/TODHYB-7 (24,248 kg/ha) recorded maximum fruit yield in IET Det., AVT-I Det., AVT-II Det., AVT-IIndet., IET AVT-I Cherry, IET Det. Hyb., and AVT-II Det. Hyb, respectively.

2.7.2.2. Development of New Strains

Emphasis was given to develop high yielding cherry tomato genotypes having desirable horticultural traits, *viz.* thick pericarp, attractive fruit colour etc. Twelve F_1s were made using diverse parents with respect to desirable horticultural traits.

2.7.3. Capsicum

2.7.3.1. Varietial Improvement

AVT-I yield evaluation trials was conducted to evaluate 6 entries including suitable checks to identify high yielding capsicum genotypes and 2018/CAPVAR-4 (15,030 kg/ha), recorded maximum fruit yield in the trial.

2.7.3.2. Development of New Strains

In capsicum, emphasis was given to develop high yielding hybrids with medium dark green fruits, thick pericarp and other important horticultural traits, suitable for protected cultivation and open field, especially under organic conditions. Nine F_1s were developed involving diverse parents. Eleven progenies derived from 12 crosses were advanced in F_2-F_7 generations for further selection.

2.7.4. Cowpea (Yard long bean)

2.7.4.1. Varietal Improvement

An IET yield evaluation trial was conducted to evaluate 6 entries including suitable checks to identify high yielding genotype. 2019/COPVAR-3 (9,442 kg/ha) recorded maximum green pod yield in the trial.

2.7.5. Garden pea

2.7.5.1. Varietal Notified

VL *Sabji Matar* 14 (VP 1018): is a medium maturity variety notified through State Varietal Release Committee (Horticulture) for Uttarakhand. It is an open- pollinated variety and takes around 126-132 days for first green pod harvest in mid hill conditions (November sown crop) with an average green pod yield of 12,500 kg/ha. Besides high yield potential, this entry possesses resistance against powdery mildew disease. The pods are long with high shelling per cent (>50).

VL *Sabji Matar* 14 (VP 1018)

2.7.5.2. Varietal Improvement

Eight evaluation trials were conducted to evaluate 59 entries with suitable checks to identify early maturing / medium maturing / edible pod genotypes with higher yields. Entries, *viz*. 2018/PEDVAR-6 (11,740 kg/ha), 2019/PEVAR-6 (10,080 kg/ha), 2018/PEVAR-1 (10,230 kg/ha), 2017/PEVAR-5 (11,250 kg/ha), 2019/PMVAR-5 (10,470 kg/ha), 2018/PMVAR-2 (10,950 kg/ha), 2017/PMVAR-4 (11,110 kg/ha)and 2019/PEDVAR-5 (10,230 kg/ha) recorded maximum green pods yield in AVT-I (Edible pod), IET (Early), AVT-I (Early), AVT-II (Early), IET (Medium), AVT-I (Medium), AVT-II (Medium) and IET(PM), respectively. VP 1332 (12,950 kg/ha) gave highest edible green pod yield in the State Varietal trials.

2.7.5.3. Development of New Strains

Emphasis was given to develop early/medium duration, edible pod genotypes with high green pod yield with escape/resistance for powdery mildew. In this endeavour, 30 new F_1s were made among selected parents to combine different horticultural traits like edible pods, earliness, high green pod yield, high shelling per cent, attractive pod color and shape as well as disease resistance *etc*. Better performing 34 F_1s were advanced for growing their F_2 generation in next season. Besides, selection was practiced in the segregating materials derived from 39 F_2s, 25 F_3s, 21 F_4s, 7 F_5s, 2 F_6s and 1 F_7s crosses. Based on desirable traits, 204 progenies derived from 95 crosses were advanced in F_3 to F_6 generations and 4 new bulks were made based on phenotypic uniformness evaluation in ensuing crop season in early and medium maturity group.

2.7.6. Onion

2.7.6.1. Varietal Improvement

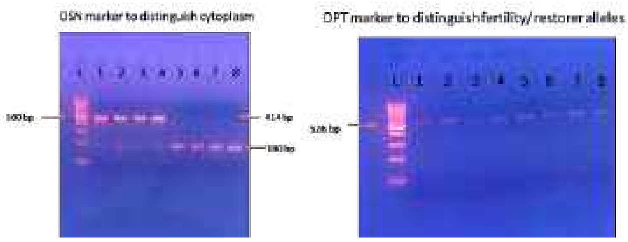
Seven AINRP trials on long day onion were conducted with 47 genotypes to evaluate their yield performance against checks. LORVA 19-02 (26,440 kg/ha), LORVB 19-30 (28,760 kg/ha), LORVC 19-37 (25,360 kg/ha), LORHA 19-65 (25,200 kg/ha), LOWTA 19-98 (19,880 kg/ha), LOWVA 19-72 (24,090 kg/ha), and LOWVB 19-84 (33,040 kg/ha) recorded maximum bulb yield in IET-Red, AVT I-Red, AVT II-Red, IET-Red-Hyb., IET-White TSS, IET-White and AVTI-White, respectively.

2.7.6.2. Development of New Hybrids

Crosses were attempted between male sterile line (VL In. 31-1A) as female and 6 diverse lines as male for the development of F_1 hybrids. Male sterile line was maintained with the help of their maintainer line VL In. 31-1B by crossing.

2.7.6.3 Validation and maintenance of developed CMS lines (VL In. 31-1A & B)

Validation of sterile line (Ssms) and maintainer line (Nmsms) using marker assisted selection. PCR-based markers, 5' cob-based marker amplified 180-bp fragment in N cytoplasm whereas in S cytoplasm amplification of two fragments (180 and 414bp) was used. Another PCR based marker of OPT, linked to the restorer of fertility (Ms) locus (Bang et al. 2011) was used to distinguish fertility restorer (Ms) locus. Line number 1-4 belongs to male sterile line (VL In. 31-1A) as female and line number 5-8 belongs to maintainer line (VL In. 31-1B).



2.7.7. Garlic

2.7.7.1. Varietal Improvement

Two AINRP trials on long day garlic were conducted with 19 genotypes to evaluate their yield performance against checks. GN 19-30 (29,080 kg/ha) in IET and GN 19-50 (30,530 kg/ha) in AVT II recorded maximum bulb yield with big clove size.

Bulbils as planting material

Bulbils as planting material in garlic (VL *Lahsun* 2) was evaluated in comparison to cloves under mid hill conditions (1250 m AMSL). The planting of date of August 30, 2019 resulted in an estimated bulb yield of 13,670 kg/ha produced through bulbils and was found statistically at par (CD @ 5% 28.55) with estimated bulb yield (15,730 q/ha) produced from the VL *Lahsun* 2- Clove crop planted on normal date *i.e.* October 30, 2019.

VL *Lahsun* 2 bulbils and cloves volume difference

Field trial of bulbils as planting material experiment

Flowering induction & true seed production in garlic

In the flowering induction trial of garlic in response to the growth regulators sprays (GA3 25, 50, 100, 200 ppm & 6-BAP 25, 50, 100, 200 ppm) with tap water control scheduled at 30 days after planting and a week before bulb initiation; no genotype/variety (VL *Lahsun* 2, CITH G-61, CITH G-03, SG-1, *Bhima* Purple, *Bhima Omkar*) except 'CITH 5' was observed to come to flowering and the 'CITH 5' was confirmed as *Allium ampeloprasum* which flowers naturally under hills. Therefore, it showed flowering even under control treatment of the experiment. No genotype could set true seed in the trial.

2.7.8. Seed Multiplication of Released and Pre-released Varieties

A total of 900 kg quality seeds were produced during the period in targeted vegetable [garden pea (250 kg), onion (3 kg), garlic (600 kg), French bean (16.5 kg) and tomato (0.5 kg)].

2.7.9. Genetic Resources–Evaluation & Maintenance

Six hundred twenty two accessions of different vegetable crops are maintained during *rabi* 2019-20 and *kharif* 2020.

2.7.10. Underutilized Vegetables

Total 84 accessions of *Dolichos* (*Dolichos purpureus*) bean (27-NBPGR, Bhowali; 2-ICAR-CIAH and 2-ICAR-research complex for Eastern region) and *Ram Karela* (*Cyclanthera pedata*) (41-NBPGR, Bhowali, 2- local collection) were collected during May, 2020 for morphological evaluation under the North-Western hill ecology. While 4 accessions of chow-chow were collected from ICAR-research complex for North-Eastern region, Meghalaya centre. Accessions of *Ram karela* (43) and *Dolichos* bean (31) were planted at spacing of 1.5 m (row to row) × 0.5 m (plant to plant) in the field, out of which 42 and 27 accessions of *Ram Karela* and *Dolichos* bean and none of the chow-chow accession germinated.

Germinated accessions of *Dolichos* bean were assessed for different morphological traits. Days to germination and flowering was ranged from 4 to 20 days and 41.5 to 74.7 days after seed sowing, respectively. The number of branch/plant, plant height (cm) and no. of leaves/plant varied between 1.5-9.5, 48.0-244.0 and 8.7–59.0 respectively. Genotype, DB-8, DB-15 and DB-18 performed better for no. of branch/plant, plant height (cm) and no. of leaves/plant, respectively. The 43 genotypes of *Ram Karela* were morphologically characterized based on the traits like days to germination, days to flowers, no. of leaves/plant, no. of branch/plant, plant height (cm) and 10 fruit weight (g). Germination started 5 days after seed sowing (RK-25) and continued up-to 16 days after seed sowing (RK-21), whereas flowering started 48 days (RK-5, RK-13) after sowing and continued upto 54 days (RK-21, RK-34). The number of branch/plant, number of leaves/ plant, plant height (cm) and 10 fruit weight (g) varied between 10.00-33, 21.67-102.0, 101.50-191.0 and 22.0-56.0, respectively. Genotype, RK-5 performed better for number of leaves/plant (102.0) and plant height (191.0 cm), and genotype RK-10 & RK-40 was found to be higher in number of branch/plant (33) and 10 fruit weight (56 g).

Flowering and fruits in *Ram Karela* (*Cyclanthera pedata*)

Flowering and fruits in *Dolichos* bean (*Dolichos purpureus*)

2.7.10. Crop Protection Investigations

2.7.10.1. Plant Pathology

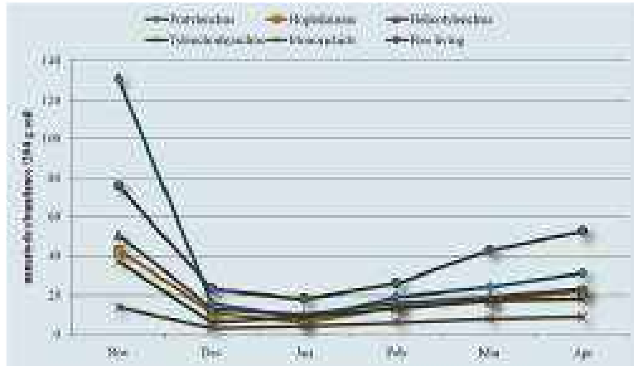
During month of March and April, major diseases observed at Experimental farm, Hawalbagh was purple blotch of onion. The per cent disease index (PDI) reached up to 80% in onion and 70% in garlic in few entries. The severity of *Stemphyllium* blight of onion was moderate. Forty-seven onion and 17 garlic entries/lines under different coordinated trials were screened under natural epiphytotic conditions. These include LD Red IET, LD Red AVT I, LD Red AVT II, LD IET Red Hybrid, LD IET White, LD White AVT I, LD White IET (HTSS) in onion and AVTI and AVT II in garlic. Only entry LORVC 19-44 under LD Red AVT II was identified promising.

Plant Pathology Investigations in Onion

A total of 29 cherry tomato entries/advance lines were evaluated against various diseases under polyhouse conditions. Entries CITH CH-3, CITH CH-5, WCT, 2016/TOCVAR-2, 2016/TOCVAR-3, 2016/TOCVAR-5, 2018/TOCVAR-1, 2018/TOCVAR-2, 2018/TOCVAR-5 and 2018/TOCVAR-6 showed resistant to highly resistant reactions against early blight, late blight and powdery mildew diseases.

2.7.10.2. Nematology

Eight samples from pea crop grown at ICAR-VPKAS, experimental farm, Hawalbag were collected. Soil nematode at different time interval and post application of Carbofuran 3G (Furadan®) @ 1 kg *a.i.*/ha across the crop season from sowing to harvesting were investigated. The parameters of community analysis indicated abundance of nematodes with 100% and 16.7% absolute as well relative frequency in all 8 samples belonging to the different trophic group including plant parasitic nematodes genera such as *Pratylenchus*, *Hoplolaimus*, *Helicotylenchus* and *Tylenchorhynchus*, Mononchids as predatory and others free living groups. Analysis of population density (mean, relative and absolute density) of nematodes revealed the dominance of *Pratylenchus* followed by free living, *Helicotylenchus*, *Tylenchorhynchus*, *Hoplolaimus* and *Mononchids*. Prominence value analysis showed the most prominence of nematode in following order *Pratylenchus*> freeliving> *Helicotylenchus*> *Tylenchorhynchus*> *Hoplolaimus*> *Mononchids.* Application of Carbofuran 3G (Furadan®) @ 1 kg *a.i.*/ha at the sowing time in pea reduces nematode density initially but the population increases slowly across the growing period of pea crop.



Change in population structure of nematode over the period after application of Carbofuran

2.8. Germplasm Evaluation for Nutritional and Physiological Parameters

ICAR-VPKAS involve basic and applied research in relation to the crop productivity and quality for major hill crops like rice, maize, pulse & oil seeds and millets. There is a large pool of promising germplasm of many field crops available in different parts of North-Western hills, which can be utilized to a great extent for nutritional and nutraceuticals security of the vulnerable population groups. An organized biochemical approach is essential to select nutritionally superior genotypes either to serve as parents or to identify well-established crop varieties with higher productivity and quality.

Screening of maize genotypes for Fe and Zn content by dye-binding method

Three hundred and ten genotypes of maize were analyzed for Fe and Zn content by dye-binding method, Total protein, Tryptophan & β- carotene through FT-NIR based non-destructive method.

Out of 310, total 94 genotypes were having high iron and 102 samples having high Zn. Fifty three genotypes were having both high Fe & Zn and out of these 53, seven genotypes (MZ-1141, MZ-1216, MZ-1228, MZ-1235, MZ-1266, MZ-1267, MZ-1268) possesses high Fe, High Zn, Protein >10.0 %, Tryp > 0.60 % and β-Carotene >10 ppm.

Screening of maize genotypes for micronutrient and other quality traits

One hundred and twelve genotypes (QPM inbreds, normal corn, CIMMYT lines, composite lines, Bajaura lines) were screened for Fe & Zn content by AAS and total protein, Tryptophan by FT-NIR method (Fig. 2.8.1.).

(A) **(B)**

Rapid iron screening by Prussian Blue (A) and Zinc by DTZ (B) staining

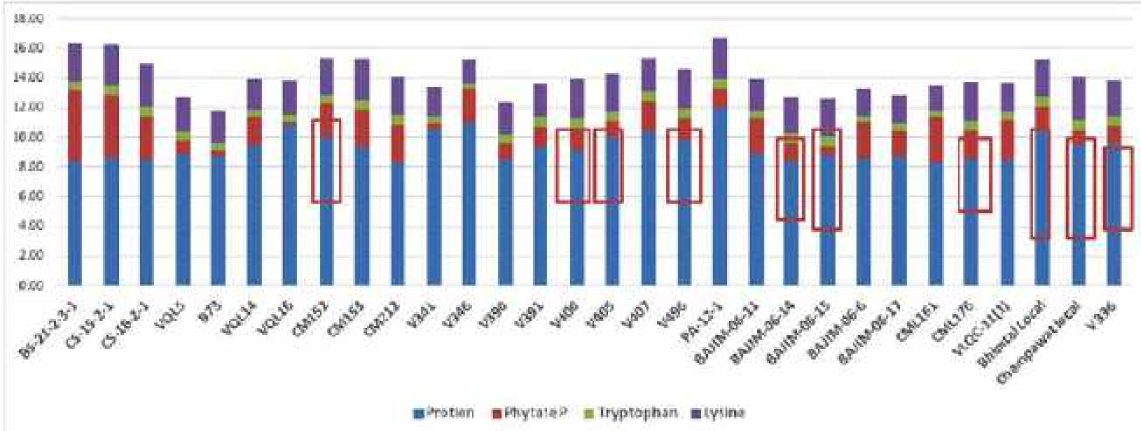


Fig. 2.8.1. Micronutrient and other quality traits of maize genotypes

Twelve inbred lines, CS-15-2-1(V336 x VQL1), CS-16-2-1(V336 x VQL1), B73, VQL14, VQL16, CM152, CM153, V346, V390, V391, V496 and PA-12-1 were found with high Fe (>40 ppm) content. Ten inbred lines (BS-21-2-3-1 (VQL2 x V336), CM127, CM212, V341, V400, V405, V407, BAJIM-06-6, CML189 and VLQC-11(1) possesses high Zinc content (>32ppm). Eight inbred lines (VQL5, BAJIM-06-11, BAJIM-06-14, BAJIM-06-15, BAJIM-06-17, CML161, *Bhimtal* Local and *Champawat* local) were found with both high Fe and Zn content. However, ten genotypes (CM 152, V336, V 400, V405, V496, BAJIM-06-14, BAJIM-06-15, CML176, *Bhimtal* Local and *Champawat* local) were with high Fe & Zn, Protein >10.0 %, Tryp >0.60% and low phytate P<2.50 mg/g content.

Effect of soaking on the flour quality in wheat

A total of thirteen varieties and advance genotypes of wheat (VL *Gehun* 829, VL *Gehun* 858, VL *Gehun* 892, VL *Gehun* 907, VL *Gehun* 953, VL *Gehun* 967, VL *Gehun* 2014, VL *Gehun* 2015, VL *Gehun* 2036, VL *Gehun* 2041, VL *Gehun* 3004, VL *Gehun* 3010, and VL *Gehun* 3014) were evaluated for effect of soaking on the flour quality. Geneotypes were divided into three parts. A part of samples was soaked in water for 24h, another portion of sample was allowed to soak for 48h and then dried in a oven at 50±2°C for 16–18h and third part without any treatment served (control). All the three types of samples were milled to flour by using Newport scientific super mill grinder with a 0.25 mm sieve. The processing of samples was done in one batch and processed samples were stored in airtight containers for further analysis. The changes in chemical composition (total carbohydrate, protein, fat, crude fiber & phytate P) after grain soaking on the flour quality in wheat was investigated. Total carbohydrate in most of the genotypes after 24 hr soaking increased significantly, while after 48 hr of soaking no significant change was found. Protein in 48h soaked seed flour increased 1.20-8.46%. Total fat decreased significantly after 48 hr soaking. Decrease was in the range of 14.68 - 30.60%. The crude fiber content in 48 hr soaked seed flour increased significantly from 10.71 (VL *Gehun* 907) to 29.61% (VL *Gehun* 892). Phytate P content decreased significantly after 24 hr soaking (14.68 - 30.60%) as well as 48 hr soaking (27.05 – 46.33%).

Screening of wheat genotypes for quality traits through FT-NIR

In wheat, high protein, carbohydrate, good chapatti and biscuit making quality *etc.* are some of the important desirable quality traits. A total 740 genotypes were analyzed for the quality parameters through thermo-fisher FT-Near Infra red spectroscopy system. The spectrum data range was 4000–10,000 cm^{-1}, number of scans was 64, and the resolution was 4 cm^{-1}.

There was wide variation in most of the nutritional attributes (Table 2.8.1), due to wide genetic basis among tested wheat genotypes. Most of the wheat genotypes exhibited >10 per cent protein with a wide variation between 9.25−11.41%; suggesting considerable genetic diversity. Similarly, considerable variations were observed in carbohydrate and total fat content which ranged between 63.88–72.93 and 2.58– 3.66% respectively. β-carotene content is also an important quality trait in case of quality wheat breeding programme.

Table 2.8.1. Quality traits of wheat genotypes

Trait	Unit	Min	Max	Mean	Variance	SD	Median
Total protein	%	9.25	11.41	10.3	0.12	0.35	10.28
Carbohydrate	%	63.88	72.93	68.26	2.65	1.63	68.21
Total fat	%	2.58	3.66	3.13	0.03	0.16	3.12
β-carotene	micro g/g	1.39	1.91	1.66	0.01	0.09	1.66
Polyphenols	mg GAE/g	0.22	0.39	0.30	0.0	0.03	0.30
Moisture	Min	13.37	14.02	13.74	0.01	0.1	13.74

β-carotene content varied between 1.39 and 1.9 µg/g. Polyphenolic compounds, recognized to have protective functions against oxidative damage, are well known natural antioxidants and are associated with reduced risk of chronic diseases. The polyphenols content in studied germplasm varied between 0.22– 0.39 mg GAE/g (Table 2.8.1.).

Screening of phosphorus uptake variability in soybean genotypes

To assess the genotypic variability for phosphorus use efficiency, 42 soybean genotypes were grown under contrasting phosphorus levels viz., P-deficit (20:0:20 kg/ha NPK) and high P (20:80:20 kg/ha NPK) under field conditions. Highest P uptake in (+P) genotypes was recorded in Birsa Soya-1 (15.80 kg/ha) whereas the highest uptake in (-P) genotypes was recorded in MAUS-1 (11.23 kg/ha) (Fig. 2.8.2.).

2.8.1. Identification and Utilization of Important Genes/Alleles/Markers in Hill Crops

Identification of genic SSR marker in barnyard millet

Barnyard millet (*Echinochloa esculenta* and *Echinochloa frumentacea*) is one of the most important minor millet crops grown in North Western Himalayan region and well known for its high nutritional values and its resistance to abiotic and biotic stresses. There are very few reports of genic/non-genic SSR marker in both the species, which limits application of molecular breeding in these two species. Development of SSR markers in these two species is required for identifying novel genes/alleles in these species by using molecular mapping approach. Since, there are few *Echinochloa* ESTs in NCBI database. Hence, SRA database (Next generation sequence repository) was searched for transcriptome data of both the species. RNA-Seq data was downloaded from NCBI SRA database Paired end Illumina HiSeq 2000 RNA-Seq data of *Echinochloa esculenta* PI647850 (accession number SRR5406170) and *Echinochloa frumentacea* Ames11429 (accession number SRR5406169) was downloaded from NCBI SRA database (https://www.ncbi.nlm.nih.gov/sra). RNA-Seq assembly of *Echinochloa_esculenta* PI647850 has total of 11.6 x10^9 bp whereas *Echinochloa frumentacea* Ames11429 has 9.5 x10^9 bp. After quality check raw data were subjected to assembly by using TRINITY. Assembly of raw data generated unigenes 43551 in *E. esculenta* and 35901 in E. *frumentacea* with N50 value 1356 and 1344, respectively. Using MISA 1831 and 2147 microsatellites motifs were found in *E. esculenta*

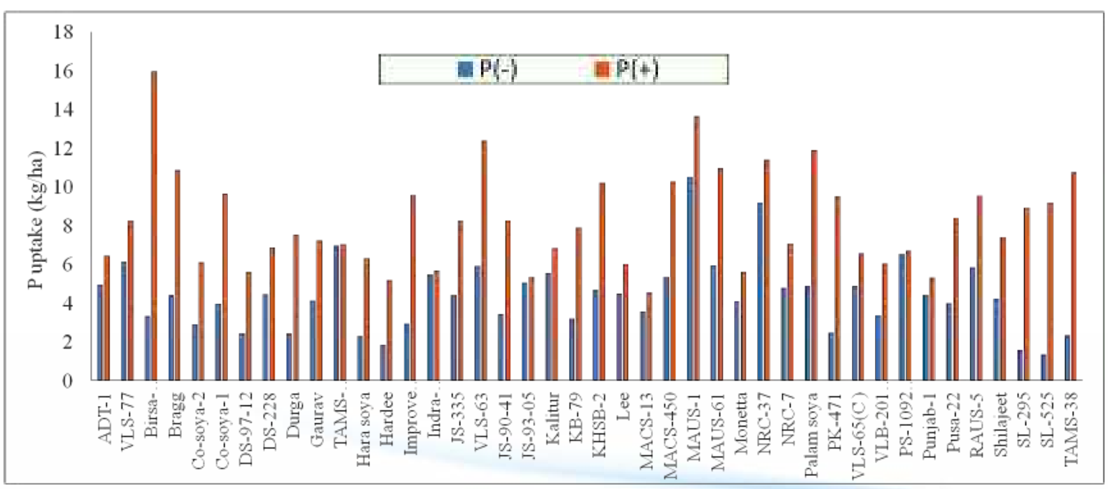


Fig. 2.8.2. Phosphorus uptake variability in soybean genotypes

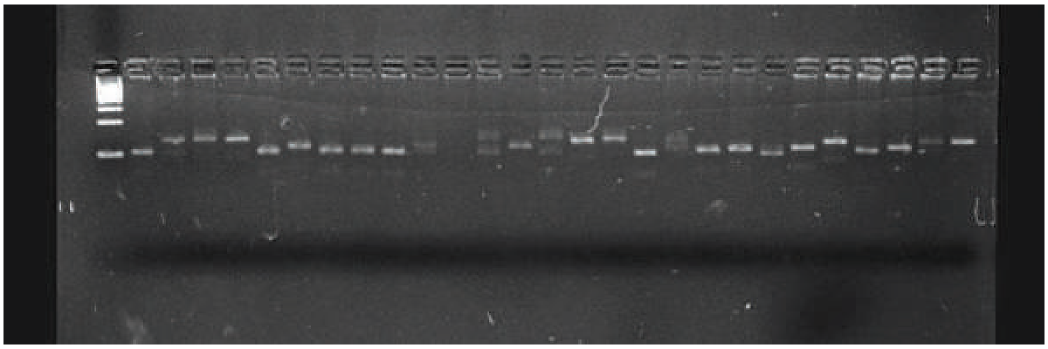


Fig. 2.8.3. Genotyping of orthologous SSR marker EFortho-1 in *E. esculenta* and *E. frumentacea* genotypes. Lane 1:100 bp ladder, *Lane 2-14: esculenta* accessions lane 15-28*: frumentacea* accessions.

and *E. frumentacea,* respectively. A total of 291 orthologus SSR marker was identified between *E. esculenta* and *E. frumentacea.* These markers can be used for comparative mapping of genes in *E. esculenta* and *E. frumentacea.*

2.9. Seed Production Programme

To cater to its clientele; the institute produces four types of seed *viz*., Nucleus Seed, Breeder Seed, Truthfully Labelled Seed and Hybrid Seed of elite varieties and hybrids. Besides the seed production of field crops, the institute produces seeds of vegetable crops. Production of breeder seed of important hill varieties is the mandate of the institute. Besides, the institute also produces Truthfully Labelled (TL) and Nucleus seed of various hill crops.

Resource poor hilly areas face a major challenge; non-availability of the quality seed (improved varieties), an important component to increase the crop production and productivity. ICAR-VPKAS, Almora a small institute from an operationally difficult area with its limited land and human resource produces four types of seed, *viz.* Nucleus Seed, Breeder Seed, Truthfully Labelled (TL) seed and Hybrid seeds of elite hybrids to caters to the quality seed requirements of its mandate area North-Western hill and additionally of the North-Eastern hill states as well as to meet the seed indent placed by DAC, Govt of India.

During the period under report, 187.0 q breeder seed of 47 released varieties/inbreds of 17 crops were produced. A total of 148.36 q breeder seed was supplied to different seed producing agencies to take up further multiplication. Around 15.07 q nucleus seed of 33 released varieties of 16 crops were also produced following standard methods of maintaining genetic purity. In addition to this, 9.93 q Truthfully Labeled seed of 20 varieties of 13 crops was produced. Including the carry-over stock of TL seed; a total of around 15.4725 q TL seed was supplied to different stakeholders.

Under farmer participatory seed production programme, 94.75 q TL seed of wheat (VL *Gehun* 953, VL *Gehun* 967, VL *Gehun* 829, VL *Gehun* 907), 2.30 q TL seed of horse gram (VL *Gahat* 19), 6.60 q TL seed of finger millet (VL *Mandua* 352), was produced, and out of it a total of 80.90 q TL seed was supplied back to different clientele.

Seed Production

Production during *Rabi* 2019 and supply in *Rabi* 2020

Crop	Variety	Breeder seed (q)		Truthfully labeled seed (q)		Nucleus Seed Prod. (q)
		Production	Supply	Production	Supply	
Wheat	VL *Gehun* 953	40.00	24.75	0.00	0.00	3.00
	VL *Gehun* 967	25.50	25.25	0.00	0.00	1.10
	VL *Gehun* 829	4.30	2.80	0.00	0.00	1.00

	VL *Gehun* 907	11.00	10.50	0.00	0.00	2.00
	VL *Gehun* 892	27.00	17.60	0.00	0.00	1.50
	VL *Gehun* 3004	4.00	3.60	0.00	0.00	1.50
	VL *Gehun* 2014	3.50	0.60	0.00	0.00	0.00
	VL *Gehun* 2015	0.60	0.00	0.00	0.00	0.00
	VL *Gehun* 832	0.00	0.10	0.00	0.00	0.00
Barley	VL *Jau* 118	3.00	3.00	0.50	0.25	0.50
Lentil	VL *Masoor* 126	0.00	0.10	0.00	0.01	0.10
	VL *Masoor* 133	1.50	4.49	0.00	0.00	0.10
	VL *Masoor* 129	0.00	1.46	0.00	0.00	0.10
Field Pea	VL *Matar* 47	0.20	0.20	0.00	0.00	0.00
Garden Pea	Vivek *Matar* 12	1.10	1.31	0.00	0.00	0.00
	VL *Sabji Matar* 13	1.50	0.59	0.40	0.00	0.10
	VL *Sabji Matar* 15	0.72	0.02	0.00	0.00	0.10
Toria	VL *Toria* 3	0.15	0.00	0.00	0.02	0.00
Onion	VL *Piaz* 3	0.00	0.03	0.00	0.01	0.01
Garlic	VL *Lahsun* 2	6.00	1.73	0.00	0.00	0.50
Radish	*Dunagiri* Local	0.00	0.00	0.11	0.13	0.00
Coriander	*Dhania* PD 1	0.00	0.00	0.45	0.45	0.00
Lahi	*Hathikaan*	0.00	0.00	0.50	0.36	0.00
Fenugreek	PEB 1	0.00	0.00	0.80	0.78	0.00
Palak	All Green	0.00	0.00	0.00	0.02	0.00
	Grand Total	**130.07**	**98.13**	**2.76**	**2.03**	**11.61**

Production during *Kharif* 2019 and supply in *Kharif* 2020

Crop	Variety	Breeder seed (q)		Truthfully labeled seed (q)		Nucleus Seed Prod. (q)
		Production	Supply	Production	Supply	
Rice	VL *Dhan157*	2.50	2.50	0.00	0.00	0.40
	VL *Dhan* 68	15.00	11.55	0.00	0.09	0.10
	VL *Dhan* 86	0.81	1.27	0.30	0.30	0.00
	VL *Dhan* 85	0.60	0.76	0.15	0.00	0.10
	VL *Dhan* 158	1.00	0.64	0.40	0.34	0.40
	VL *Dhan* 209	0.15	0.03	000	0.00	0.00
Maize	Vivek *Sankul Makka* 35	4.80	4.22	0.00	0.26	0.20
	VL Amber Popcorn	0.00	0.05	0.00	0.00	0.00
	VLS 16 (CMVLSC1 F)	0.10	0.00	0.00	0.00	0.00
	VSL 4 (CMVLSC1 M)	0.10	0.00	0.00	0.00	0.00
	V 373 (VMH 45 & 47 F)	4.48	3.30	0.00	0.00	0.00
	V 390 (VMH 45 M)	0.95	0.70	0.00	0.00	0.00
	V 391 (VMH 47 M)	0.20	0.00	0.00	0.00	0.00
	V 407 (VMH 53 F)	0.60	0.75	0.00	0.00	0.00
	V 409 (VMH 53 M)	0.40	0.40	0.00	0.00	0.00
	V 412 (VLMH 57 F)	1.20	0.50	0.00	0.00	0.00
	V 433 (VLMH 57 M)	0.35	0.25	0.00	0.00	0.00
	CM VL 55	0.00	0.00	0.00	0.05	0.00
	VMH 45	0.00	0.00	0.00	0.35	0.00

	VMH 53	0.00	0.00	0.00	0.18	0.00
	CMVL Sweet Corn 1	0.00	0.00	0.37	0.11	0.00
	CMVL Baby Corn 2	0.00	0.00	4.15	0.67	0.00
Mandua	VL *Mandua* 352	1.80	1.595	0.00	0.015	0.02
	VL *Mandua* 347	1.06	1.115	0.00	0.00	0.02
	VL *Mandua* 380	0.70	0.70	0.00	0.0425	0.02
	VL *Mandua* 376	1.00	0.885	0.00	0.055	0.02
	VL *Mandua* 379	2.50	2.65	0.00	0.21	0.02
	VL *Mandua* 348	0.28	0.28	0.00	0.00	0.02
Madira	VL *Madira* 207	0.70	1.00	0.00	0.03	0.02
Soybean	VL *Soya* 65	6.50	6.02	1.00	2.41	1.00
	VL *Soya* 63	2.80	2.60	0.55	0.09	0.00
	VL *Soya* 89	4.60	4.67	0.00	0.00	0.75
Horse gram	VL *Gahat* 19	0.20	0.76	0.10	008	0.15
Pigeon pea	VL *Arhar* 1	0.85	0.40	0.00	0.04	0.15
Buckwheat	VL *Ugal* 7	0.40	0.48	0.00	0.02	0.01
Amaranth	VL *Chua* 44	0.18	0.10	0.00	0.07	0.01
S. squash	Australian Green	0.00	0.00	0.00	0.01	0.00
French bean	VL *Bean* 2	0.12	0.05	0.00	0.00	0.05
Okra	VL *Bhindi* 2	0.00	0.00	0.15	0.10	0.00
	Grand Total	**56.93**	**50.225**	**7.17**	**13.4425**	**3.46**

	Farmers Participatory Seed Production (q)		
Crops	**Varieties**	**Production *Kharif* 2019**	**Supply *Kharif* 2020**
Horse gram	VL *Gahat* 19	2.30	2.30
Finger millet	VL *Mandua* 352	6.60	6.60
Total		**8.90**	**8.90**

	Farmers Participatory Seed Production (q)		
Crop	**Varieties**	**Production *Rabi* 2019-20**	**Supply *Rabi* 2020-21**
Wheat	VL *Gehun* 953	16.30	13.74
	VL *Gehun* 967	41.38	24.73
	VL *Gehun* 829	13.55	12.05
	VL *Gehun* 907	23.52	21.48
Total		**94.75**	**72.00**

VLQPH 59 F1 seed production in Dolkhet area, Hawalbag farm

3. Natural Resource Management for Sustainable Productivity

Research Projects

- Crop Management for Higher Soil Quality and Sustainability in Indian Himalayas *[Drs. Dibakar Mahanta, P.K. Mishra, V.S. Meena (on deputation w.e.f., May 26, 2020), Manoj Parihar, R.P. Meena & Priyanka Khati (on maternity/childcare leave)]*
- Enhancing Productivity and Profitability of Major Hill Crops through Efficient Resource Utilization *[Drs. Sher Singh, J.K. Bisht, P.K. Mishra, B.M. Pandey, Dibakar Mahanta, V.S. Meena (on deputation w.e.f., May 26, 2020) & Er. Utkarsh Kumar]*
    - ➢ **Sub Project:** Identification of Micro Watershed (Natural Spring) Using Remote Sensing & GIS Technique and its Runoff Estimation For Potential Water Harvesting [*Er. Utkarsh Kumar (PI)]*
- Farm Mechanization and Post-harvest Management for Mountain Regions *[Er. Shyam Nath, Drs. B.M. Pandey, Sher Singh, Kushagra Joshi, R.P. Yadav, Jitendra Kumar & J.K. Bisht]*
- Agro-forestry and Fodder Production Management with Emphasis on Utilization of Marginal Lands in Hills *[Drs. J.K. Bisht, R.P. Yadav, P.K. Mishra, B.M. Pandey, V.S. Meena (on deputation w.e.f., May 26, 2020), Er. Shyam Nath, Jitendra Kumar & Manoj Parihar]*
    - ➢ **Sub- Project:** Evaluation and Refinement of Suitable Agroforestry Practices for hills [*Dr. R.P. Yadav (PI)]*
- Water Harvesting and Effective Utilization of Water for Enhancing Crop Productivity and Input Use Efficiency *[Drs. S.C. Panday, Mahipal Chaudhary (on study leave), Er. Shyam Nath, Er. Utkarsh Kumar, R.P. Yadav, Jitendra Kumar, Manoj Parihar, R.P. Meena, Priyanka Khati (on maternity/childcare leave), Ashish Kumar]*

3. Natural Resource Management for Enhancing Productivity

Basic and strategic research programme of farming systems and operational management of inputs for harnessing sustainable production were carried out. These include tillage, water harvesting, intensive cropping, long term fertility management, Integrated Plant Nutrient Supply (IPNS), weed management, forage & grassland and agroforestry management, farm machinery and post-harvest technology, plasticulture engineering and technology in hilly regions.

3.1. Crop Management for Higher Soil Quality and Sustainability

Comparative influence of organic and chemical amendments on rainfed wheat-soybean cropping system

The economic optimum wheat equivalent grain yield of 10,234 and 10,360 kg/ha through farmyard manure (FYM) and vermi-compost (VC) were produced with application of 38.5 and 36.5 kg P/ha, which were 26 and 27% higher than the recommended NPK, respectively, from rainfed soybean-wheat cropping system (Fig. 3.1.1). The net return from economic optimum yield through FYM and VC were 72,987 and 68,119 Rs/ha, which were 11.0 and 4.0% higher than NPK, respectively. The level of P required from FYM and VC to achieve the same yield as recommended NPK were 12.9 and 12.1 kg P/ha, respectively. But this yield under FYM and VC will provide 10 and 11% less net return compared to NPK, respectively.

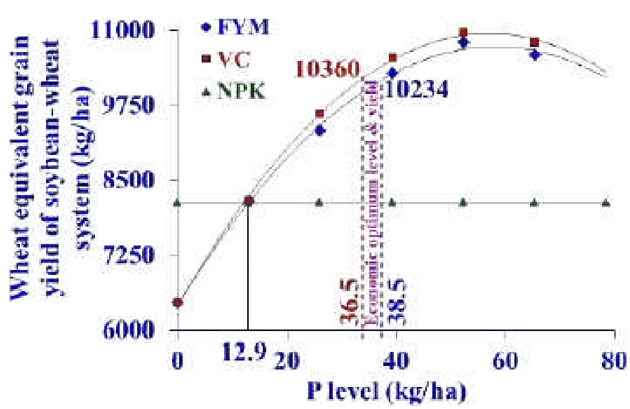


Fig. 3.1.1. Response of wheat equivalent grain yield of rainfed soybean-wheat cropping system to P application through farmyard manure and vermi-compost

Response of P application from different sources to soybean-wheat cropping system on soil respiration and microbial biomass carbon (MBC)

The soil respiration increased as the level of FYM and VC increased up to 52.4 kg P/ha. The soil respiration with application of 52.4 kg P/ha through FYM and VC provided 44 and 54% higher value compared to the recommended NPK, respectively (Fig. 3.1.2). The level of P required from FYM and VC to achieve the similar cumulative soil respiration as recommended NPK (1012 mg CO_2 g^{-1} soil) were 20.46 and 25.51 kg P/ha, respectively. Among various nutrient sources, application of VC @ 65.5 kg P/ha provided highest MBC (129 µg g^{-1} soil), which was 71% higher than the recommended NPK (75 µg g^{-1} soil). The MBC with amendment of VC (109.42 µg g^{-1} soil) provided 9.0% higher MBC than FYM (99.86 µg g^{-1} soil).

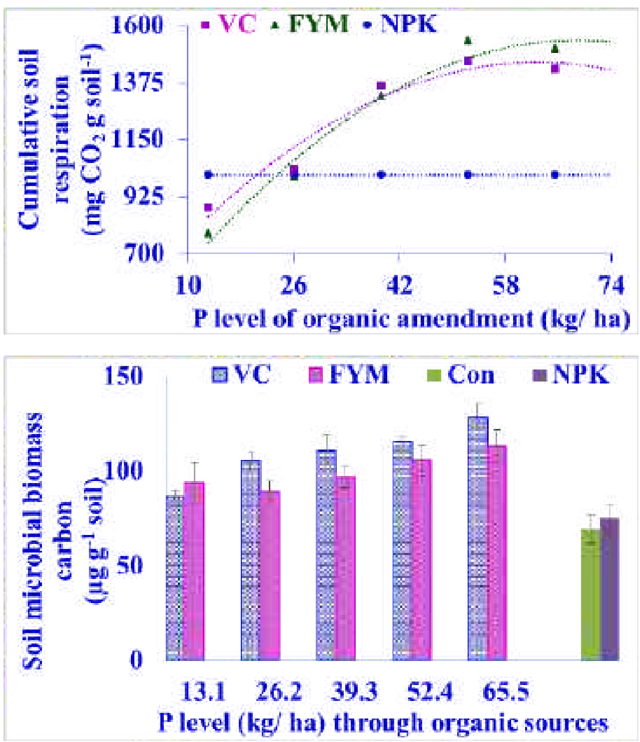


Fig. 3.1.2. Response of P application from different sources to soybean-wheat cropping system on soil respiration and MBC

Comparative influence of organic and chemical amendments on irrigated wheat-maize cropping system

Farmyard manure (FYM) and vermi-compost (VC) were evaluated against recommended NPK (150-60-60 and 120-60-40 kg N-P_2O_5-K_2O/ha) under irrigated wheat-maize cropping system. The highest wheat equivalent grain yield of 14,347 kg/ha was recorded with application of FYM @ 300 kg N/ha, which was 18% higher than the NPK plot. The level of N required from FYM to achieve the same yield as recommended NPK was 216 kg N/ha.

Productivity evaluation of soybean-wheat crop rotation under long term fertility management

The analysis of grain yield data after 47 years of experimentation under rainfed soybean-wheat system confirmed that the application of FYM along with inorganic fertilizer provided an increase in the wheat equivalent grain yield than the first year (1973-74) (Fig. 3.1.3). Different combinations of inorganic fertilizer provided the decrease pattern of grain yield compared to the first year. The average wheat equivalent grain yield from the system with the application of 10 t/ha FYM along with the recommended NPK (6,841 kg/ha) recorded 104% higher compared to the recommended NPK (3,359 kg/ha), which confirmed that the application of only chemical fertilizer is not sustainable.

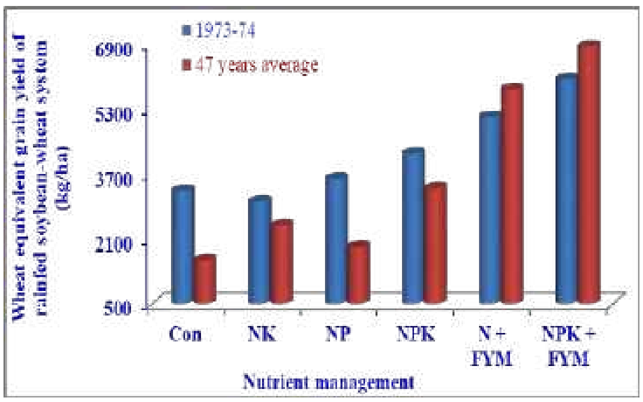


Fig. 3.1.3. Comparative wheat equivalent grain yield of rainfed soybean-wheat system

Organic and inorganic P status under long term fertility management

Long term field experiment revealed that combined application of organic and inorganic fertilizers (NPK + FYM) significantly improved organic, inorganic and total phosphorus content than rest of the treatments (Fig. 3.1.4). The organic, inorganic and total P under NPK + FYM were 94, 70 and 78% higher compared to sole application of NPK, respectively. However, there was no significant difference among inorganic fertilizer treatments.

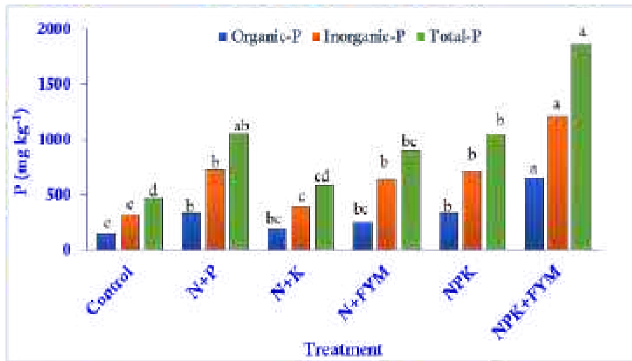


Fig. 3.1.4. Impact of long-term organic and inorganic fertilization on different fractions of phosphorus (Different letter on similar colour bar represents significant (p < .05) differences among treatments according to DMRT)

Response of cold tolerant 'P' solubilizing Pseudomonas strains on yield of lentil

Two elite cold tolerant 'P' solubilizing *Pseudomonas* strains (*Pseudomonas* sp. RT5RP(2) and *Pseudomonas fragi* CS11RH1) along with uninoculated control were used for seed inoculation of three lentil varieties (VL *Masoor* 126, VL *Masoor* 507 & VL *Masoor* 514) to study their response on nutrient uptake, growth and yield of lentil under field conditions using factorial RBD. All effects were statistically significant at 0.05 significance level. The main effects for varieties yielded $F(2,18) = 5.28$ $p<0.05$ indicating a significant difference between varieties, however, interaction F (4,18) = 1.53 $p>0.05$ was non-significant. Bacterization with cold tolerant PSB *Pseudomonas fragi* CS11RH1 recorded highest grain yield of 1,567 followed by 1,467 and 1,415 kg/ha for VL *Masoor* 507, VL *Masoor* 126 and VL *Masoor* 514, respectively over the uninoculated control (1,350, 1,314 & 1,146 kg/ha). (Fig. 3.1.5.).

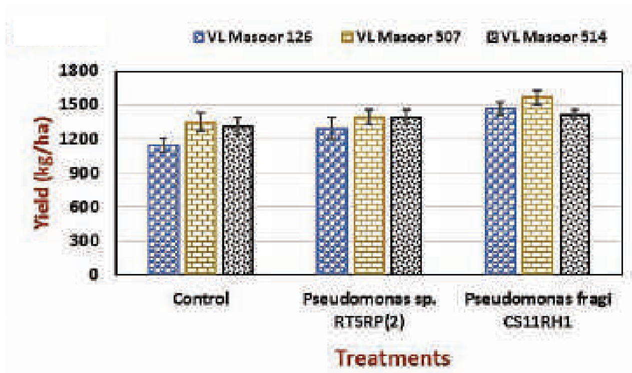


Fig. 3.1.5. Effect of cold tolerant P solubilizing *Pseudomonas* strains on yield of different lentil varieties

Response of cold tolerant 'P' solubilizing consortium on yield of different varieties of lentil

Two elite cold tolerant 'P' solubilizing consortium {C2 (PB2RP1 (2), NS12RH2 (1), CS11RP1) and C3 (PB2RP1 (2), NS12RH2 (1), CS11RH4)} along with uninoculated control (C0) were used for seed inoculation of three lentil varieties (VL *Masoor* 126, VL *Masoor* 507 & VL *Masoor* 514) to study their response on nutrient uptake, growth and yield of different varieties of lentil under field conditions using factorial RBD. All effects were statistically significant at 0.05 significance level. The main effects for varieties yielded $F(2,18) = 63.7$ $p<0.05$ indicating a significant difference between varieties. Bacterization with cold tolerant P solubilizing bacterial consortium C2 recorded significantly higher lentil grain yield of 1,629, 1,592 and 1,472 kg/ha for VL *Masoor* 507, VL *Masoor* 514 and VL *Masoor* 126, respectively compared to uninoculated control (1,266, 1,216 & 1,080 kg/ha, respectively). The interaction effect was significant $F(4,18) = 18.9$ $p<0.05$ (Fig. 3.1.6.).

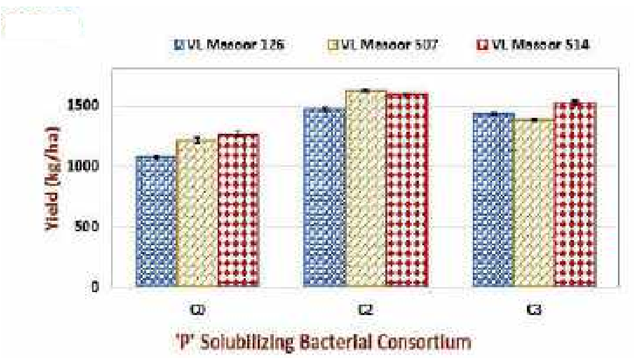


Fig. 3.1.6. Effect of cold tolerant P solubilizing bacterial consortium on yield of different lentil varieties

3.2. Enhancing Productivity and Profitability of Major Hill Crops through Efficient Resource Utilization

Effect of tillage, mulching and sowing methods on productivity of rainfed finger millet-wheat cropping system

Among sowing methods, seed drill sowing resulted 9.2% higher wheat grain yield than normal line sowing (3,181 kg/ha) and 12.5% higher than farmer's practice (2,957 kg/ha). Mulching through hoeing resulted 11.8% higher yield than no mulch (3,141 kg/ha). The zero tillage (3,388 kg/ha) gave 3.8% more grain yield than the conventional tillage (3,264 kg/ha). Sowing with seed drill under zero tillage with mulch fetched highest net returns of Rs 69,362/ ha with BC ratio of 3.03. Seed drill sowing resulted into 8.2% higher wheat straw yield than normal line sowing (5,188 kg/ha) and 9.1% higher than farmer's practice (5,142 kg/ha), whereas mulching through hoeing resulted into 10.8% higher straw yield than no mulch (5,124 kg/ha). The zero tillage gave only 3.5% more straw yield than the conventional tillage (5,307 kg/ha).

Finger millet-wheat cropping system was evaluated for tillage, mulching and sowing methods under rainfed conditions. The analysis revealed that Walkley Black Soil Carbon (WBSC) varied non-significantly under the effect of tillage, mulching and sowing methods. The higher WBSC was recorded under zero tillage (6.17 g/kg) and mulching (6.30 g/kg) over conventional tillage (5.98 g/kg) and no mulching (5.86 g/kg) in 0-15 cm soil layer. However, no difference in WBSC was recorded between transplanting and line sowing methods (6.08 g/kg). Similar trend of WBSC was recorded in 15-30 cm soil layer, however, higher WBSC was recorded on surface layer (0-15 cm) over sub-surface layer soil (15-30 cm).

Optimization of nitrogen doses for higher yield potential

Two growth regulators, namely lihocin and folicur were applied with different nutrient management to manage the lodging of wheat. Two sprays of lihocin @ 0.2% + folicur @ 0.1% at first node and flag leaf stage (8,058 kg/ha) along with application of 180-90-60 kg/ha N-P_2O_5-K_2O provided significantly higher grain yield than the rest treatments, which was 8% higher than without application (application of 180-90-60 kg/ha N-P_2O_5-K_2O only). There was no lodging with spraying of growth regulators; however, the lodging score of wheat without application of growth regulators was 3.5. The reduction of crop height with spraying of growth regulators helped in avoiding lodging. Application of both lihocin and folicur reduced 10 cm plant height.

Response of cold tolerant PGP Pseudomonas strains on nutrient uptake, growth and yield of different varieties of wheat

Two elite *Pseudomonas* strains (*Pseudomonas* sp. PPERs23 and *Pseudomonas* sp. NARs9) along with uninoculated control were used for seed inoculation of three wheat varieties (VL *Gehun* 504, VL *Gehun* 907 & VL 804) to study their response on nutrient uptake, growth and yield of different varieties of wheat under field conditions using factorial RBD. All effects were statistically significant at the 0.05 significance level. The main effects for varieties yielded F (2,18) = 94.4 p <0.05 indicating a significant difference between varieties. Bacterization with cold tolerant PGP *Pseudomonas* sp. NARs9 recorded higher grain yield of 2,720 and 2,339 kg/ha for VL 804 and VL *Gehun* 907, respectively compared to uninoculated control (2,108 & 2,115 kg/ha, respectively). However, VL *Gehun* 953 achieved higher yield (2,721 kg/ha) with PGP *Pseudomonas* sp. PPERs23 over the uninoculated control (2,596 kg/ha). The interaction effect was significant F (4,18) =16.0 p<0.05. (Fig. 3.2.1).

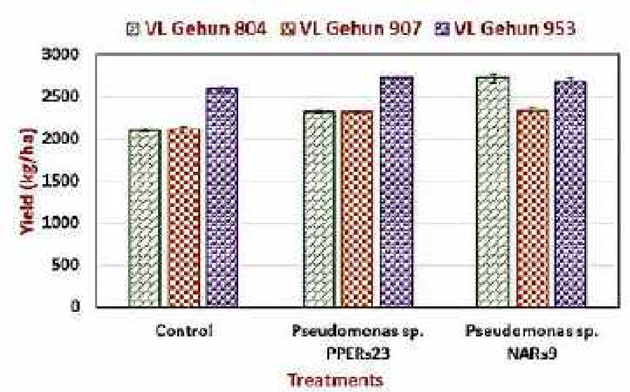


Fig. 3.2.1. Effect of cold tolerant PGP Pseudomonas strains on yield of different wheat varieties

Response of cold tolerant PGP Consortium on nutrient uptake, growth and yield of different varieties of wheat

Two elite cold tolerant PGP consortium {Consortium C2 (PGRs4, PPERs23, PCRs4) and Consortium C4 (PPRs4, PCRs4, PGRs1)} along with uninoculated control were used for seed inoculation of three wheat varieties (VL 804, VL 907 & VL *Gehun* 953) to study their response on nutrient uptake, growth and yield of different varieties of wheat under field conditions using factorial RBD. All effects were statistically significant at the 0.05 significance level. The main effects for varieties yielded F (2,18) = 7.00 p<0.05 indicating a significant difference between varieties, however, interaction F (4,18) = 1.33 p>0.05 indicating non-significant effect. Bacterization with cold tolerant PGP consortium C4 recorded higher grain yield of 3,513 and 4,013 kg/ha for VL 804 and VL *Gehun* 953, respectively over uninoculated control (2,476 & 3,139 kg/ha). However, VL *Gehun* 907 achieved higher yield (3,038 kg/ha) with consortium C2 over the un-inoculated control (2,502 kg/ha) (Fig. 3.2.2).

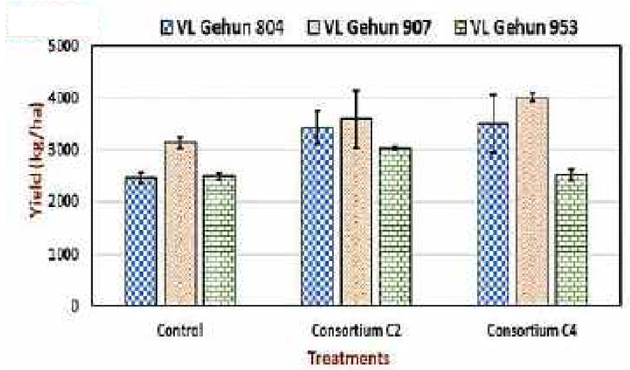


Fig. 3.2.2. Effect of cold tolerant PGP bacterial consortium on yield of different wheat varieties

3.3. Farm Mechanization and Post-Harvest Management in Mountain Region

Designing and development of VL Maize Sheller

Design for the development of VL Maize sheller was accomplished using Creo Parametric 4.00 (CAD Software). There are pointed bolts (25.4 x 6 mm) fixed in the rotor. The overall dimension of the machine was 1100 × 500 × 1000 mm. The main component of the sheller were frame, half hp electric motor, rotor, threshing drum, feeding chute (hopper). Power from electrical motor was transmitted to shelling rotor through "V" belt and pulley. The shelling rotor was rotated approximately from 1000 to 1200 rpm. The overall weight of the machine was 50 kg.

The average shelling capacity and efficiency was 305 kg/h and 98%, respectively at 14% moisture content and 10° working slope. The speciality of this sheller was threshing of maize cobs without breaking of the cob wood. Farmers use this whole cob as fuel wood in their domestic use.

Table 3.3.1. Performance of VL Maize sheller

Shelling slope (degree)	10.0
Average moisture content (%)	13.7
Average threshing efficiency (%)	98.0
capacity (kg/hr)	305.45

Design and development of foot operated hand wash device

"VL Foot Operated Hand Wash Device" was designed and developed for washing hands without touch. It was found very useful in current scenario of COVID-19 outbreak for minimizing CORONA virus spread, especially in community areas. It has two separate foot operated pedals, *viz.* one for pressing hand wash liquid and other for pressing water tap. Arrangement of mechanical linkages helps in the pressing operations. Locally available pressmatic tap has been used for water. Hand wash bottle (200 ml) has been used for liquid soap/ detergent. Separate stoppers have been used for controlling the flow of liquid hand wash and water. Water tank up-to 500-liter capacity was used in this device. There is a provision of wash basin for hygienic hand washing/cleaning. Weight of the device was about 25 kg (without water tank) and can be easily installed anywhere as per requirement. The overall dimension of the device along with tank was 0.87×0.80×2.2 meter. MS angle, MS sheet and MS flat were used as raw material for its development. It was developed during first lock down period of COVID-19 (Fig.3.3.1). Water saving percentage of the developed device was approximately 418% compared to conventional tap water used in domestic purpose. Foot operated hand sanitizer (alcohol based) device (Fig.3.3.2) was also developed during the period.

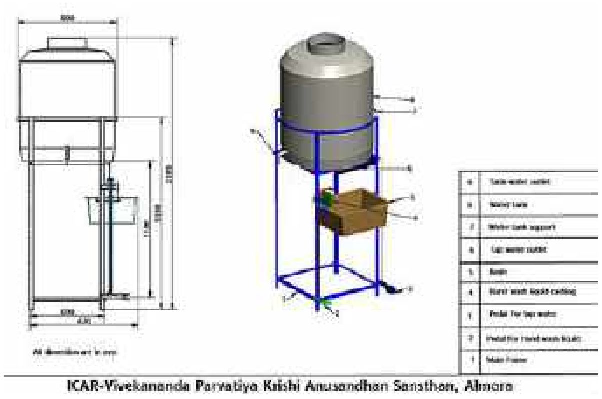


Fig. 3.3.1. Foot operated hand device for hand washing

Fig.3.3.2. Foot operated hand sanitizer device

3.4. Agroforestry and Fodder Production Management with Emphasis on Utilization of Marginal Lands in Hills

Evaluation of grasses

Bajra napier hybrid: Out of sixteen entries in varietal trial of bajra napier hybrid, entry VTBN-2019-16 produced significantly higher green fodder (31,309 kg/ha) and dry fodder (8,348 kg/ha) than rest of the entries.

Evaluation of cultivated fodder

Oat: In Initial Varietal Trial (IVT) on oat, out of 9 entries, entry IVTO MC-2 produced significantly higher green fodder (23,187 kg/ha) than entries IVTO MC-4, 6, & 9 and dry fodder (6,029 kg/ha) than rest of the entries, except entries IVTO MC-5 & 7.

Berseem: Out of 6 entries in IVT of berseem, IVTB-1 produced significantly higher green fodder (18,400 kg/ha) compared to IVTB-2 & IVTB-6. The IVTB-1 also recorded significantly higher dry fodder (3,660 kg/ha) compared to rest entries.

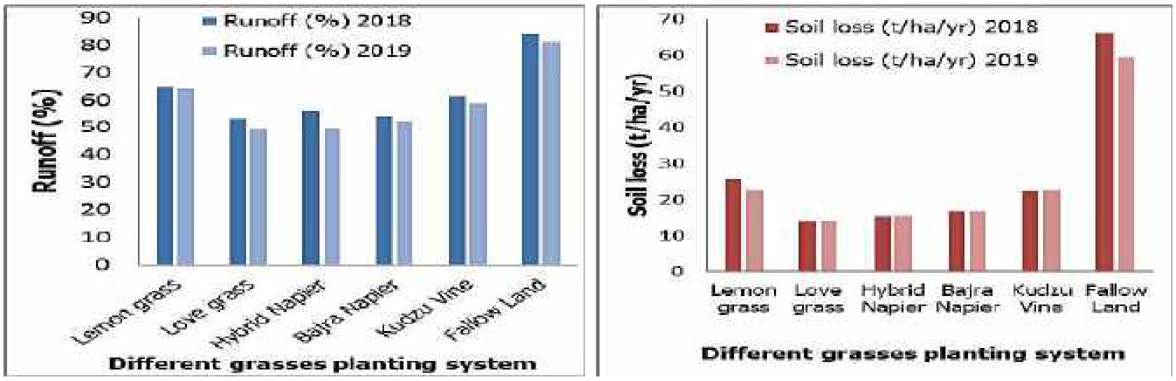
Maize: Out of 19 entries of IVT of maize, significantly higher green forage (35,416 kg/ha) and dry fodder (7, 672 kg/ha) was obtained from entry IVTM-10 than rest of the entries.

Investigation on fodder trees

The *kachnar* (*Bauhinia retusa*) tree planted on field terrace and as wayside plantation was investigated for different cutting management on the growth and forage yield. In case of *kachnar* field terrace plantation, the highest green forage (6.16 kg/tree) and fuel wood yield (2.75 kg/tree) was recorded from lopping of tree twice in a year and pollarding at 2 m height leaving main shoot intact (LMSI), respectively. Whereas, in case of wayside plantation of *kachnar*, lopping leaves and tender twigs twice in a year produced highest green forage (10.8 kg/tree) and pollarding at 1 m height LMSI recorded highest fuel wood yield (2.81 kg/tree).

Estimation of runoff and soil loss under different grass planting systems in sloping land

The effect of five different grass planting systems namely Kudzu vine, bajra napier, hybrid napier,



(a) (b)

Fig. 3.4.1 Effect of different grass planting system on surface runoff (%) and soil loss (t/ha/yr)

Fig. 3.4.2 Nutrients losses due to water erosion in year 2018 and 2019 under different grasses planting system

love grass and lemon grass were evaluated on run off and soil loss compared with control treatment. The run off and soil loss were significantly reduced under the different grass were evaluated systems as compared with control treatment. On the basis of two years of field evaluation, the average surface run off and soil loss generated through love grass, hybrid napier and bajra napier planting system *i.e.* 51.32%, 52.83%, 53.09% and 14.18, 15.44, 16.71 t/ha/yr, respectively, when the average annual rainfall was 1000.13 mm and land slope 43.14% The love grass was found to be the most effective to control surface runoff (37.79%), soil loss (77.5%), and nutritional loss (77%) compared to control treatment (Fig 3.4.1 a and b) (Fig. 3.4.2).

Agroforestry

Agri-horti system

Fruit-based

Soybean-wheat cropping system was assessed in fruit tree (17-year-old) based agri-horti system in which fruit trees (Hill lemon, plum, pear and apricot) were planted at a spacing of 6 m × 6 m. The maximum soybean and wheat grain yield was recorded in sole cropping (1.98 & 3.28 t/ha, respectively) followed by under plum (1.69 & 3.06 t/ha, respectively). Under trees, the grain yield of soybean and wheat reduced from 14.6 to 36.3% and 6.7 to 34.1%, respectively (Fig. 3.4.3.). Green fodder yield varied between 2,378 and 3,795 kg/ha.

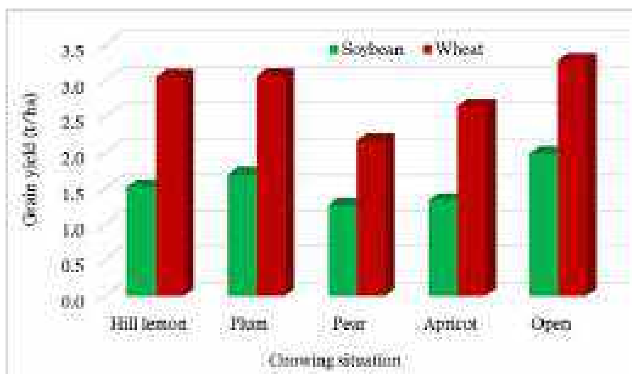


Fig. 3.4.3. Performance of soybean and wheat in fruit-based agri-horti system

Peach-based

In peach (13 years old) based agri-horti system finger millet (VL *Mandua* 149, 324, 315 and 347) and wheat (VL *Gehun* 804, VL *Gehun* 892, 829 and 907) varieties were evaluated in which peach was planted at 3 m × 4 m spacing. It was noted that sole cropping yielded higher finger millet (6.54%) and wheat (25.2%) grain compared to under peach. However, among varieties VL *Mandua* 149 (1.84 t/ha) of finger millet and VL

804 (2.92 t/ha) of wheat recorded highest yield (Fig. 3.4.4.). Mean wheat equivalent grain yield (WEGY) was significantly higher in sole cropping (5.60 t/ha/year) that was 15.70% more than under peach. However, total (crop + peach) mean gross return was more than three-fold higher under peach as compared to sole cropping.

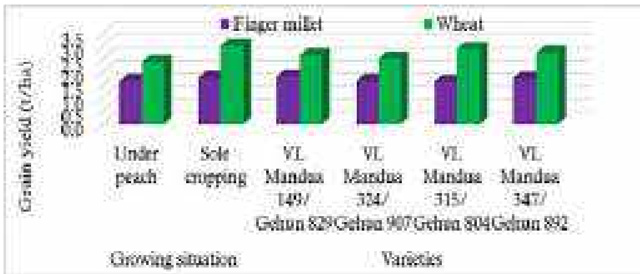


Fig. 3.4.4. Performance of different varieties of finger millet and wheat in peach-based agri-horti system

Silvi-horti system

Soil available nutrients under oak based silvi-horti system

Soil available nutrients such as nitrogen (N), phosphorus (P) and potassium (K) were estimated under oak-based silvi-horti sytem. Other than potassium, soil N and P content was influenced significantly by various cutting treatments. However, these parameters were at par under varietal treatments. Among various cutting management options, the highest N content (~493 kg/ha) was recorded with pollarding at 3 m height which was 1 to 3% higher than other cutting treatments and ~7% than open (461 kg/ha) (Fig. 3.4.5.). Almost similar trend was observed for phosphorus and potassium where cutting treatments performed better than the sole cropping (open).

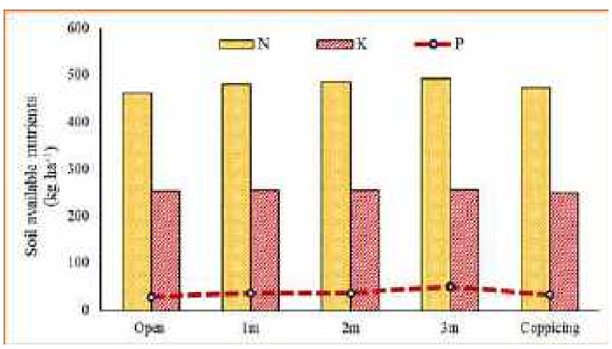


Fig. 3.4.5. Effect of oak cutting management on soil available nutrients (NPK) in silvi-horti system

Silvipasture System

Fodder trees *Quercus leucotrichophora, Grewia optiva, Morus alba, Bauhinia retusa* and *Melia azedarach* along with four cutting management *viz.*, coppicing, pollarding at 1 m height, pollarding at 2 m height and pollarding at 3-meter height with *Setaria kazungula* under these trees were tested under silvi-pastoral system. During winter season, the highest green fodder leaves (3,408 kg/ha) was yielded by *Quercus lecuotrichophora*, however, in case of cutting management pollarding at 3 m height produced the highest green fodder leaves (3,866 kg/ha). In *kharif* season, *Setaria sphacelata* (cv. *kajungula*) grass produced the highest green fodder (5,137 kg/ha) under *Melia azedarach*. Whereas, under lopping management the highest green forage yield was obtained with cutting at 3 m height (4,717 kg/ha) from grass (Fig. 3.4.6.).

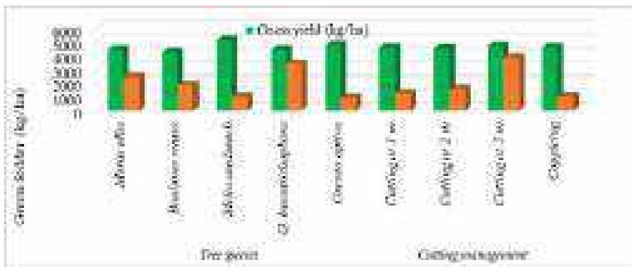


Fig. 3.4.6. Green fodder yield from grass and trees with different cutting management in silvipasture system

Carbon Sequestration

Total biomass C of the peach tree was 22.9 Mg/ha, in which contribution of aboveground biomass C and belowground biomass C were 79.3% and 20.6%, respectively (Fig. 3.4.7.). Under peach C stock of the soil (15.7, 13.9 and 29.6 Mg/ha) was significantly ($P<0.05$) higher at 0-15, 15-30 and 0-30 cm depth, respectively as compared to sole cropping. System C stock was significantly higher under peach tree (52.6 Mg/ha) with contribution of 56.34% of soil C stock and 43.6% of peach tree biomass C stock compared to sole cropping (23.8 Mg/ha).

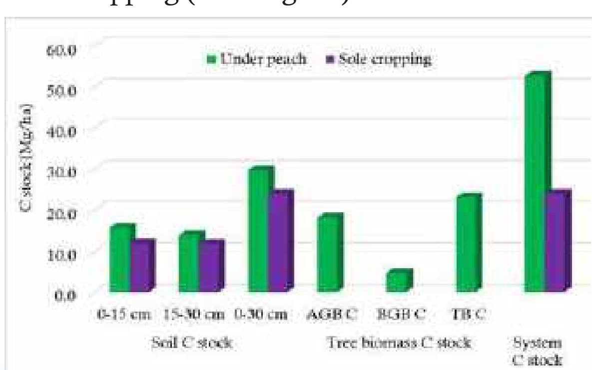


Fig. 3.4.7. Soil, tree biomass and system C stock in peach-based agri-horti system

Production and distribution of planting material

Planting material {pecan sapling (85), fodder trees (588) and grasses (19.0 q) were produced and distributed to various stakeholders *i.e.* farmers, NGOs, research organizations, state department etc.

3.5. Water Harvesting and Effective Utilization of Water for Enhancing Crop Productivity and Input Use Efficiency

Irrigation requirement of wheat-rice rotations in relation to tillage alterations

The direct sown rice-wheat rotation was evaluated with limited irrigation under zero and conventional tillage. The higher wheat yield was recorded under zero tillage plots (3,598 kg/ha) in comparison to conventional plots (3,048 kg/ha). Significant increase in wheat yield was recorded with increasing levels of irrigation. The highest water productivity was recorded with one irrigation, followed by two and three irrigation. Lowest water productivity was recorded with four irrigation (Fig 3.5.1).

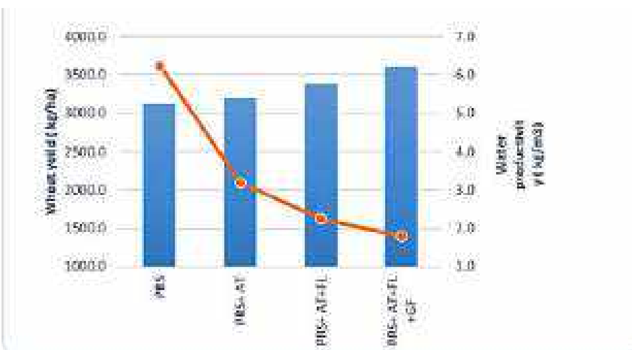


Fig 3.5.1. Water productivity of wheat as influenced by tillage and irrigation

Soil moisture and nutrient dynamics in wheat-soybean rotation under irrigated conditions

Wheat was grown under fertilized condition and soybean was grown on the residual fertility, baring one treatment where it was grown with recommended NPK. Application of recommended NPK+10 t FYM recorded significantly higher wheat grain yield (5,046 kg/ha). The FYM application gave higher yield (3,484 kg/ha) in comparison to N alone (1,651 kg/ha). The lowest grain yield was obtained in control (1,457 kg/ha) (Fig 3.5.2). The water productivity followed the same trend as in the case of grain yield. The application of NPK+ FYM in *rabi* season gave highest yield (2,294 kg/ ha) of soybean followed by direct application of recommended NPK fertilizer (2,145 kg/ha) during both *kharif* and *rabi* season followed by N+FYM and FYM (Fig 3.5.2).

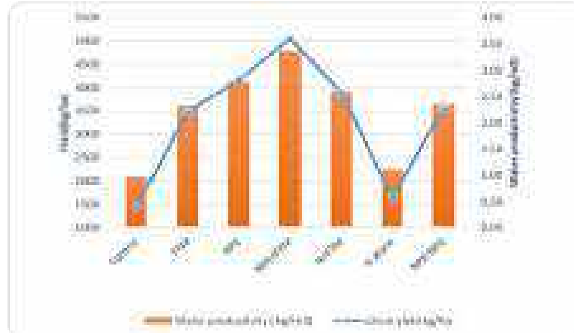


Fig 3.5.2. Wheat yield and water productivity under different level of nutrients

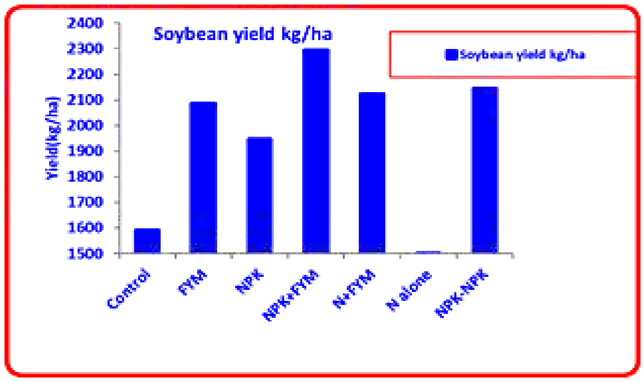


Fig 3.5.3. Effect of residual and direct application of NPK on soybean yield

The soil enzymes activity was estimated under various nutrient supply options in irrigated wheat-soybean system (Fig. 3.5.4.). The urease activity

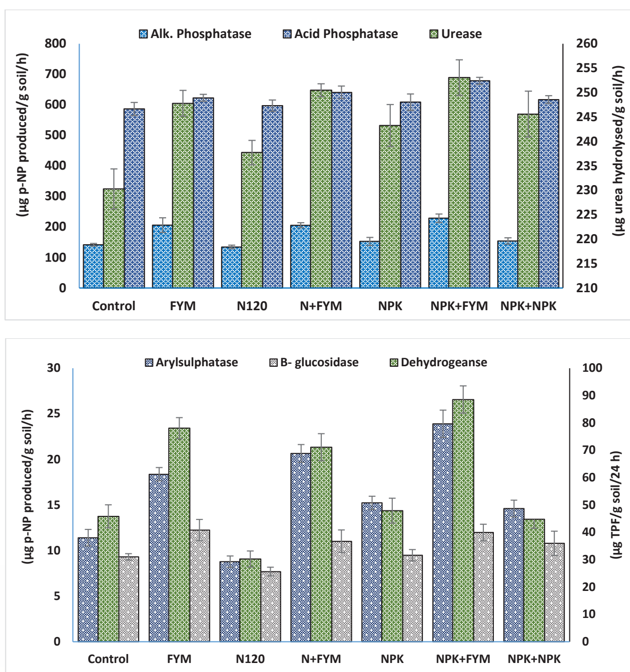


Fig. 3.5.4. Effect of various nutrient supply options on soil enzymes activity under wheat- soybean cropping system

(µg urea-N hydrolyzed/g soil/h) was found highest under NPK+FYM (253) followed by N+FYM (251) and FYM (248) while lowest in control (230) treatment. Almost similar trend was recorded for dehydrogenase, phosphatase (acid and alkaline), arylsulphatase and β-glucosidases but lowest value was observed in only N fertilized plots followed by control treatment.

The DTPA-extractable Zn, Cu, Fe and Mn content, under various nutrient application treatment plots in irrigated wheat-soybean system were ranged from 0.66 to 0.95, 0.65 to 1.07, 33 to 53 and 30 to 43 mg kg^{-1}, respectively (Fig. 3.5.5.).

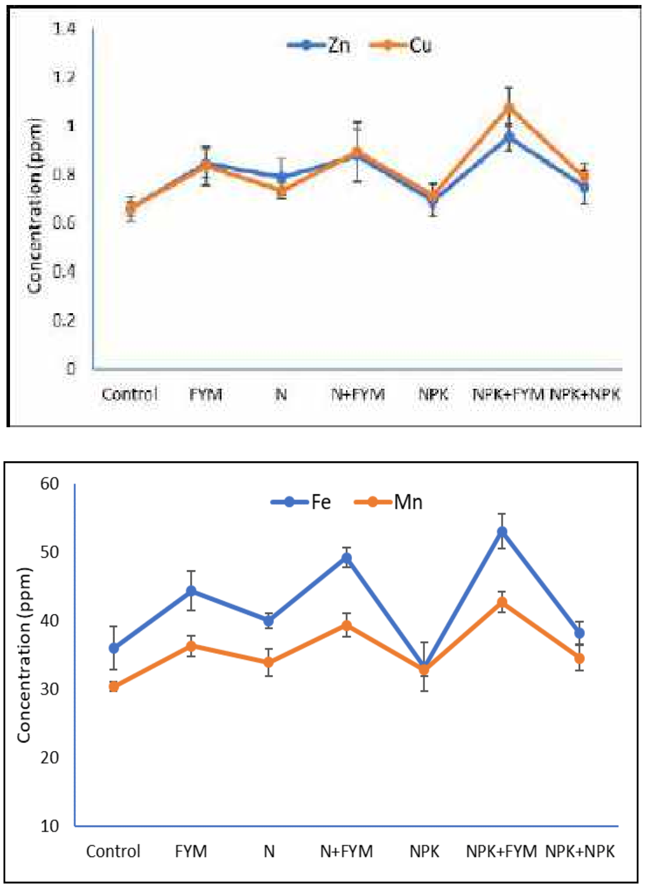


Fig. 3.5.5. Effect of various nutrient supply options on soil micronutrients (Zn, Cu, Fe and Mn) content under wheat-soybean cropping system

Artificial recharging techniques for hill springs

One of the springs located at ICAR-VPKAS Hawalbagh farm was selected to revive because its discharge was greatly reduced due to heavy construction on its catchments. Therefore, recharging of ground water became zero. The roof water as well as surface water was harvested in trenches along with plantation on trenches to avoid evaporation and enhance time of concentration of water to increase the water concentration in aquifer recharging zone.

The comparative study revealed that the five year mean annual discharge of the spring was higher 73.2, 100.7, 114.2, 135.9, 148.8, 145.8, 138.6, 142.6, 135.7, 134.0 and 136.5 per cent during 2006-2010, 2007-2011, 2008-2012 and 2009-2013, 2010-2014 2011-2015, 2012-2016, 2013-2017, 2014-2018, 2015-2019 and 2016-2020, respectively in comparison to annual discharge recorded during 2000 before the inception of the treatments (Fig. 3.5.6.). Although five yearly mean annual rainfall was below by -19.4, 13.5, -15.5, -13.6, -12.5 -24.2 -27.4, -27.1, -32.2, -34.4 and -33.0 per cent during above mentioned years. The annual discharge was 111.8 per cent higher during 2020 in comparison to discharge recorded before treatment inception in 2000.

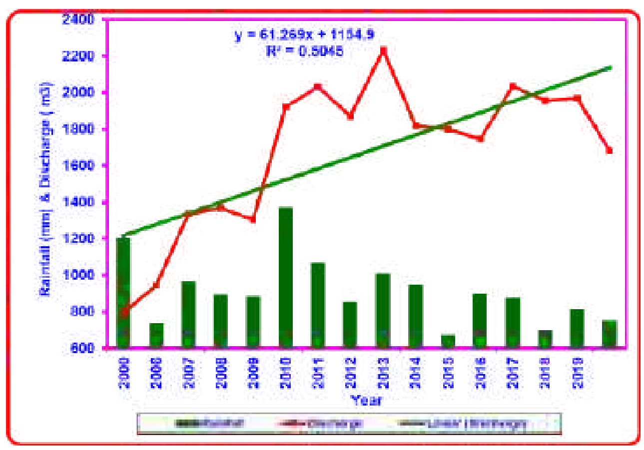


Fig. 3.5.6. Annual rainfall and discharge in different years from spring before and after treatments.

4. Integrated Pest Management

Research Projects

- Race Profiling, Variability and Management of Major Plant Pathogens of Hill Crops *[Drs. Rajashekara, H., K.K. Mishra, ARNS Subbanna, Jeevan B. and Ashish Kumar Singh, Chandan Maharana (w.e.f 17.10.2020)]*
- Bio-Intensive Management of Major Polyphagous Pests of Uttarakhand Hills *[Drs. A.R.N.S. Subbanna, Rajashekara H and Amit Umesh Paschapur]*
- Studies on Physico-Chemical Properties and Microbial Dynamics of Compost and Casing Soil in Relation to Fructification and Yield of White Button Mushroom (*Agaricus bisporus*) *[Drs. K.K. Mishra, P.K. Mishra and V.S. Meena (w.e.f. May 26, 2020)]*

4. Integrated Management of Diseases and Pests of Hill Crops

Crop protection measures play a vital role in reducing the crop yield losses by disease and insect-pests management. Integrated methods of management are environmentally safe and important in hill ecosystem. Thus, emphasis has been given on the use of varietal resistance, biological control options, organic amendments, and safer pesticides including survey and identification of important diseases and insect pests of hill crops.

4.1. Survey and Surveillance

During *kharif* 2020, major diseases observed in soybean at Hawalbagh and farmers' field in Almora district were Frogeye Leaf Spot (FLS), bacterial pustules and pod blight. The highest severity was observed in September. Bacterial pustule and pod blight were observed with low-moderate intensity. Leaf and neck blast diseases of rice were moderate to severe (40-50%) with 5-7 score on 0-9 scale. False smut incidence was low (<5%). Brown leaf spot of rice was moderate in farmer's field. In maize, turcicum leaf blight and rust were moderate to severe. The incidence of brown spot caused by *Physoderma maydis* was observed in moderate form in experimental trials. The severity of leaf, neck and finger blast of finger millet was moderate to severe. Low to medium incidence of shoot fly (15-20%) was also observed. In barnyard millet moderate to high incidence of grain smut disease was observed under farmer's field conditions.

Barnyard millet grain smut disease was observed under farmer's field conditions

In wheat and barley, yellow rust severity was medium to high (20S to 80S), at experimental farm, Hawalbag. However, at farmers' field it was low. Most of the experimental lines at Hawalbagh showed the symptoms of powdery mildew from low to medium severity (1-5 score on 0-9 scale). Low to medium incidence of shoot fly in wheat and barley (15-20%) was also observed. In garden pea, very low severity of wilt (2%), medium to high severity of purple blotch and *Stemphylium* blight (30-50%) in onion and garlic were noticed during March-April months.

High infestation of aphids in mustard and red pumpkin beetle in cucurbits was found during March. Medium infestation of pea leaf miner was noticed during March-April. In polyhouses, low infestation of white flies in tomato and medium incidence of aphid and mites in capsicum was found. In soybean, low to medium infestation of sucking bug, *Chauliops* and aphids have been observed.

Fall armyworm (*Spodoptera frugiperda*) was first noticed in foot hills of Uttarakhand near Udham Singh Nagar during *kharif* 2019. This devastating pest was observed in majority of the maize growing areas of medium to high hills in cropping season 2020. Surveys (28) were conducted during crop season and it was found that the damage was severe.

Fall armyworm (*Spodoptera frugiperda*)

Tuta absoluta is one of the serious pests of tomato causing extensive damage in many countries and it was first reported in Uttarakhand hills during May 2018 in tomato grown under polyhouses (Bhagartola, Almora, a MGMG village of ICAR-

Tomato pin worm (*Tuta absoluta)*

VPKAS). During *kharif* 2020, the infestation was low to moderate in tomato growing areas especially under polyhouse.

During the first week of August, 2020 attack of locusts was reported from KVK, Kafligair, Bageshwar for the first time in hills. However, the size of the swarm was small and showed no damage of crops.

A bio-control agent parasitizing *Rhizoctonia solani* of maize under field conditions in KVK, Kafligair, Bageshwar was collected. Isolation of the fungus was carried out and pure culture showed the fungus as *Trichoderma* spp.

Bioagent parasitizing maize plant infected with *R. solani* and its pure culture

4.2. Race Profiling, Variability and Management of Major Plant Pathogens of Hill Crops

Wheat rust pathotypes

The yellow rust samples analyzed at IIWBR Regional Station, Flowerdales showed the dominance of pathotype 238S119. However, brown rust samples collected from Uttarakhand, showed that pathotypes belonging to 77-5 followed by 77-9, 77-1, 12-4 and 104-A. There was increase in the proportion of pathotype 77-5 as compare to previous year. However, the most predominant pathotype for leaf rust from Himachal Pradesh was 104-2. During May 2020, winter wheat entry FRTL/NEMURA was found infected with stem rust pathogen. Pathotyping analysis confirmed the presence of pathotype 11 (79G31).

Wheat yellow rust and brown rust

Screening of maize inbred lines for turcicum leaf blight (TLB) resistance

A set of 120 inbred lines were screened for TLB under artificial inoculation conditions and 36 entries showed highly resistance reaction with 1 score, 17 entries with 2 score and 28 with 3 score, (Fig. 4.2.1.)

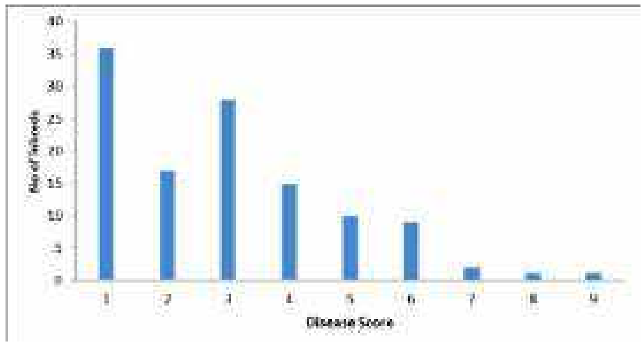
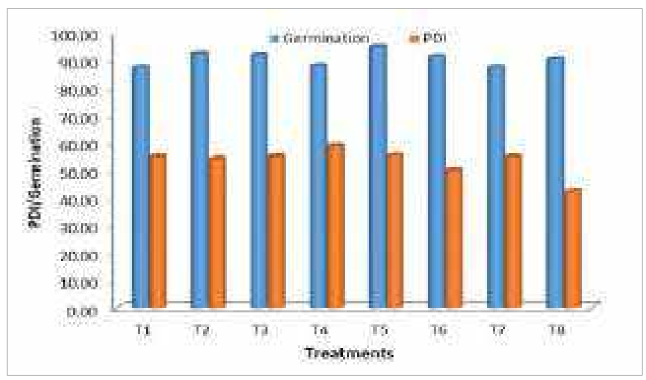


Fig. 4.2.1. Categorization of maize inbred lines based on disease reaction

Management of Turcicum Leaf Blight (TLB) using integrated approach

A total of 8 different bio-agents and chemical fungicides were evaluated against turcicum leaf



{**T1**-control; **T2**-Seed treatment with Tr 28 @ 10gm/kg seeds + spraying at time of disease appearance @ 10gm/lit. of water; **T3**-Seed treatment with Tr 202 @ 10gm/kg seeds + spraying at time of disease appearance @ 10gm/lit. of water; **T4**-Seed treatment with bacterial bioagent Pf 10 @ 10gm/kg and spraying at time of disease appearance @ 10gm/lit. of water; **T5**-Seed treatment with mancozeb + Carbendazim @ 2gm/kg and spraying at time of disease appearance @ 1gm/lit. of water; **T6**- Seed treatment with mancozeb @ 2.5 gm/kg and spraying at time of disease appearance @ 2gm/lit. of water; **T7**- Seed treatment with Carbendazim @ 2gm/kg and spraying at time of disease appearance @ 1gm/lit. of water; **T8**-Seed treatment with azoxystrobin @ 2ml/kg seeds and spraying at the time of disease appearance @ 1ml/lit}

Fig. 4.2.2. Response of bioagents and fungicides on turcicum leaf blight of maize

blight incidence and its management to reduce the yield losses caused by *Exserohilum turcicum* (Fig. 4.2.2.). Among the treatments, T8 *i.e.* seed treatment with azoxystrobin @ 2ml/kg seeds and spraying at the time of disease appearance @ 1ml/lit was found effective (42.2%) in reducing the disease followed by T6 *i.e.* seed treatment with mancozeb @ 2.5 g/kg and spraying at time of disease appearance @ 2g/lit. of water (49.8%) in comparison to control (54.8%).

Phenotyping and molecular profiling of rice entries for blast disease

A total of 50 rice entries were evaluated for their reaction to leaf and neck blast in the Uniform Blast Nursery (UBN). Based on the disease score, 29 and 21 entries were found highly resistant to leaf and neck blast, respectively. The scoring data indicates the frequency of positive allele of R gene ranged from 8 to 14 in different entries. The entries, *viz*. VL 8654, VL 8657 and VL 31694 possess maximum number of R genes (13) (Fig. 4.2.3.).

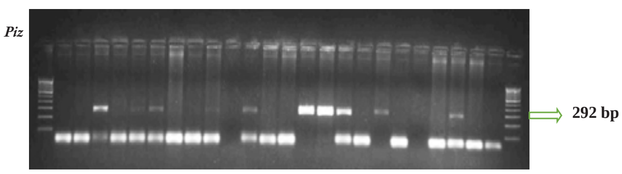


Fig. 4.2.3. PCR amplification of blast R gene

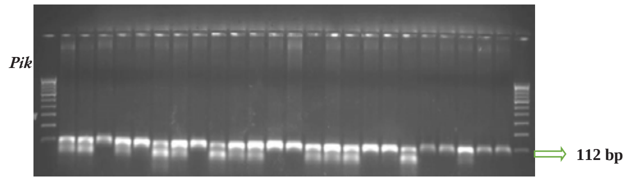


Fig. 4.2.3. Genotyping of rice entries for blast R gene

Assessment and distribution of plant parasitic nematodes (PPN)

A total of 23 and 12 composite soil samples were collected at different time interval in wheat and pea crops, respectively. The results indicated the prevalence of 7 genera including *Helicotylenchus*, *Tylenchorhynchus*, *Hoplolaimus*, *Meloidogyne*, *Pratylenchus*, *Xiphinema* and *Criconematids* in wheat (Table 4.2.1.). Among these genera, *Helicotylenchus* was found to be the most prevalent in wheat crop. While in pea crop, the association of *Pratylenchus* was the most abundant (Table 4.2.1. & 4.2.2.).

Characterization of entomo-pathogenic nematodes (EPN)

Soil samples were collected from Mukteshwar area and baited against *Corcyra* larvae. Only one sample was positive for entomogenous nematodes. It was characterized using morphology and molecular approach (based on internal transcribed spacers (ITS) region amplification (1450 bp) and sequencing) (Fig. 4.2.4.), and identified as *Pristionchus pacificus*

Table 4.2.1. Nematode diversity associated with wheat crop

Nematode	Frequency/200g soil	Absolute Frequency (%)	Relative Frequency (%)	Absolute density	Relative density
Helicotylenchus	63	52.1	20.9	31.5	18.2
Tylenchorhynchus	21	30.1	9.7	9.4	6.1
Hoplolaimus	26	32.1	9.4	26.0	7.4
Meloidogyne	32	35.1	12.2	51.0	9.9
Pratylenchus	23	31.1	10.1	14.1	8.1
Xiphinema	15	16.3	4.7	7.4	3.2
Criconematids	12	15.3	3.9	6.8	2.9

Table 4.2.2. Nematode diversity associated with pea crop

Nematode	Frequency/200g soil	Absolute Frequency (%)	Relative Frequency (%)	Absolute density	Relative density
Pratylenchus	72	56.0	26.7	37.2	18.0
Hoplolaimus	14	15.6	8.2	11.5	5.3
Helicotylenchus	23	21.2	12.3	13.8	8.2
Tylenchorhynchus	9	8.7	5.3	11.8	3.2
Mononchids	8	8.3	5.1	3.6	3.1
Free living	12	10.1	6.3	21.7	4.5
Pratylenchus	72	56.0	26.7	37.2	18.1

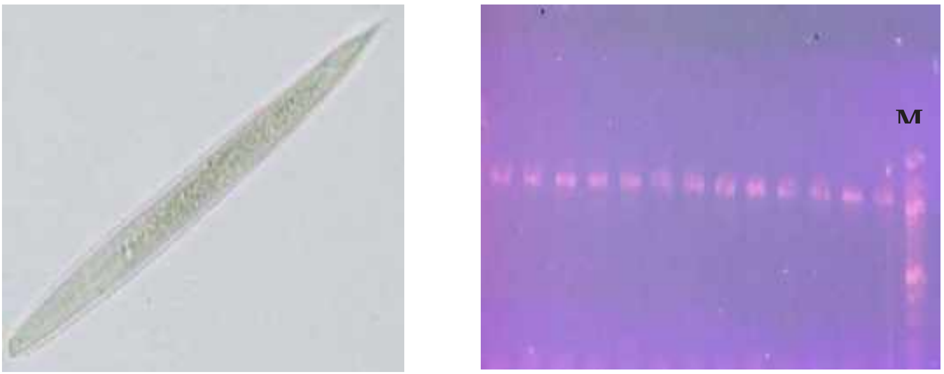


Fig. 4.2.4. Morphological and molecular characterization of *Pristionchus pacificus*

(Fig. 4.2.5.). The host range study of *Pristionchus pacificus* indicated their parasitism and multiplication behaviour against *Corcyra*, *Spodoptera* and *Holotrichia* insect-pests.

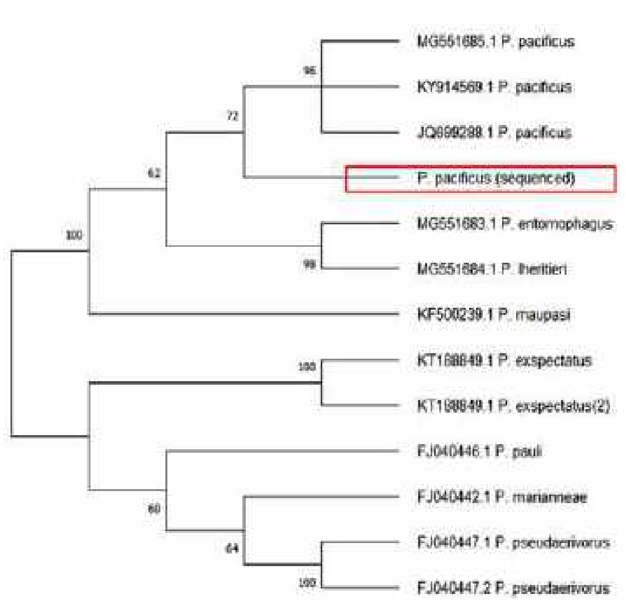


Fig. 4.2.5. Phylogenetic relationships among *Pristionchus* spp.

4.3. Bio-intensive Management of Major Polyphagous Pests of Uttarakhand Hills

Light trap catches of different species of white grubs

During May to October 2020, a total of 16,397 beetles were trapped in 10 light traps installed at the Experimental Farm, Hawalbagh, which was higher than the beetles trapped during year 2019 (8,062 beetles). As that of previous years, maximum catch (8053) of beetles accounting to 49.1% of total catch was recorded during June month. Diversity of the beetles comprised of 60 species, of which predominant species was *Anomala* sp. accounting to 14.28%. *Anomala dimidiata* became the third predominant species which comprise only 8.98% of the total catches in comparison to 12.12 % of previous year. Other predominate species are *Maladera similana*, *Hemiserica nasuta* and *Holotrichia longipennis* with 10.5, 7.01 and 4.6% of total catch,

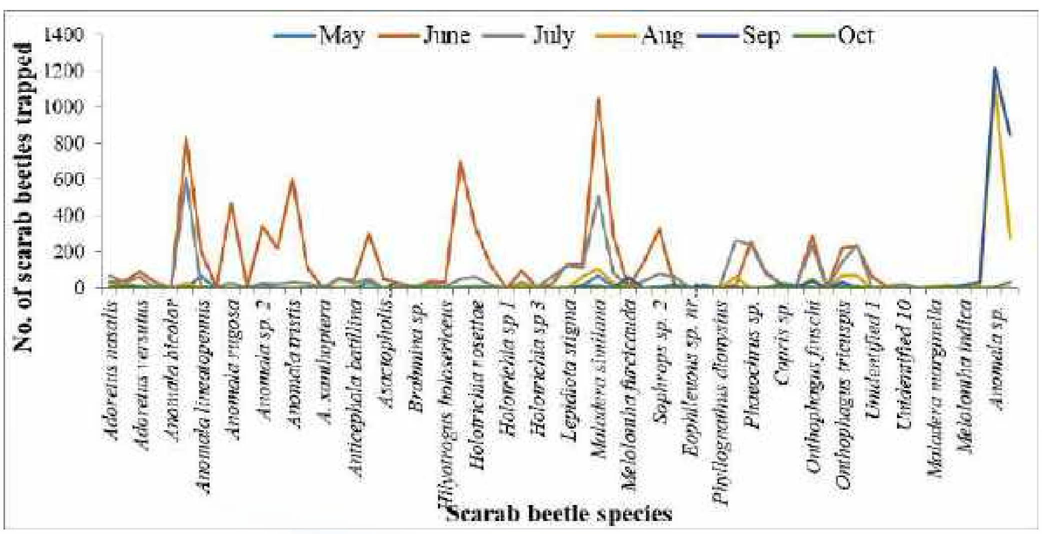


Fig. 4.3.1. Species composition of light trap catches during May-October 2020

respectively. With respect to subfamily, rutellinae, melolonthinae dynastinae and scarabinae accounts to 38.55, 41.61, 2.99 and 10.79% of total catch, respectively. The species composition of light trap catches is given in the Fig.4.3.1.

Survey, collection and morphological characterization of whiteflies from North Western Himalayan region

An extensive survey was conducted in 26 locations comprising three states (Uttarakhand, Himachal Pradesh and Tripura) and union territory (Delhi) to collect whitefly samples from both protected cultivation system and open field conditions (Table 4.3.1.). Among the locations surveyed, two major whitefly species were observed *viz.*, greenhouse whitefly (*Trialeurodes* spp.) and cotton whitefly (*Bemisia* spp.) infecting 11 host plants. The species delimitation studies showed that, *Trialeurodes* spp. was widely distributed in cold and temperate climates, whereas, *Bemisia* spp. was distributed in hot and humid climates.

Molecular characterization of Alternaria spp. strain VLH1

Molecular characterization was carried to identify the fungi upto species level by sequencing ITS 5.8S ribosomal gene using primear pairs and sequences were submitted at NCBI GenBank (MN704636 and MN704637, respectively). The NCBI GenBank BLASTN search of the obtained nucleotide

Table 4.3.1. Survey for collection of whiteflies from North Western Himalayan region

Location	District	State	Host plant	Latitude	Longitude	Moprhological identification
Hawalbagh	Almora	UK	Salvia and French bean	29.634082	79.631259	*Trialeurodes* sp.
Almora	Almora	UK	Salvia and marigold	29.589508	79.645099	*Trialeurodes* sp.
Kafligair	Bageshwar	UK	Tomato	29.751903	79.744241	*Trialeurodes* sp.
Doba	Bageshwar	UK	Capsicum, Potato, cauliflower	29.805475	79.703495	*Trialeurodes* sp.
Niglat Malla, Kainchi	Nainital	UK	Capsicum	29.401018	79.514373	*Trialeurodes* sp.
Darim	Nainital	UK	Tomato	29.457497	79.635877	*Trialeurodes* sp.
Dwarahat		UK	Tomato and capsicum	29.767179	79.425900	*Trialeurodes* sp.
Govindpur	Almora	UK	Frenchbean	29.68223	79.56524	*Trialeurodes* sp.
Rudradhara	Bageshwar	UK	Ornamental	29.855093	79.567875	*Trialeurodes* sp.
Pantnagar	Udham singh nagar	UK	Tomato and Brinjal	29.027109	79.479966	*Trialeurodes* sp. and *Bemisia tabaci*
Mussoorie	Dehradun	UK	Ornamental and Brinjal	30.480667	78.052262	*Trialeurodes* sp.
Chopta	Rudraprayag	UK	Ornamental	30.489287	79.217040	*Trialeurodes* sp.
Gopeshwar	Chamoli	UK	Capsicum and tomato	30.436796	79.320747	*Trialeurodes* sp.
Valley of flowers	Chamoli	UK	Ornamental	30.726323	79.599393	*Trialeurodes* sp.
Kasauli	Solan	HP	Brinjal and cauliflower	30.898403	76.979865	*Trialeurodes* sp.
Kufri	Shimla	HP	Potato	31.099063	77.264912	*Trialeurodes* sp. and *Bemisia tabaci*
Kasol	Kullu	HP	Potato and ornamental	32.010927	77.319074	*Trialeurodes* sp.
New Delhi	New Delhi	Delhi	Cotton and Brinjal	28.641237	77.169133	*Bemisia tabaci*
Lembucherra	West tripura	Tripura	Tomato and potato	23.904222	91.314826	*Bemisia tabaci*
Jal Dhalar Someshwar	Almora	UK	Capsicum and French bean	29.784681	79.602904	*Trialeurodes* sp.
Mehragaon, Bhimtal	Nainital	UK	Ornamental	29.373460	79.557965	*Trialeurodes* sp. and *Bemisia tabaci*
Ranibagh	Nainital	UK	Capsicum and potato	29.286033	79.547461	*Trialeurodes* sp. and *Bemisia tabaci*
Nainital	Nainital	UK	Ornamental	29.389418	79.465673	*Trialeurodes* sp.
Pangoot	Nainital	UK	Cauliflower and capsicum	29.424456	79.427403	*Trialeurodes* sp.
Jageshwar	Almora	UK	Capsicum and potato	29.639179	79.852336	*Trialeurodes* sp.
Daulaghat	Almora	UK	French bean and tomato	29.67982	79.56708	*Trialeurodes* sp.

sequence showed *Alternaria* species with maximum homology of 99.81% with *Alternaria alternata* strain ZH2-5 (Accession No. MT487769.1). While, a homology of 99% and above was also found with a number of other *Alternaria* species like, *A. tamaricis, A. tenuissima, A. arborescens, A. compacta, A. solani* and *A. brassicae*. However, it may have evolved along with the other *Alternaria* species from a close phylogenetic relation with *A. solani* which is a well-known plant pathogenic fungus of tomato. While, *Curvularia ischaemi* was taken as an outgroup.

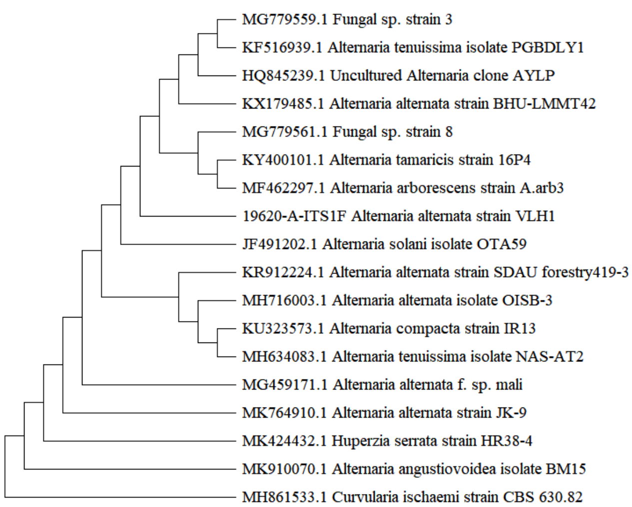


Fig. 4.3.2. Phylogenetic tree generated from maximum likelihood (ML) analysis based on ITS gene sequences.

Studies on protein production by Alternaria spp. VLH1 and its toxicity against aphid pests

The kinetics of protein production from the fungi *Alternaria* sp. strain VLH1 (Fig 4.3.3.) showed that, on day 4, highest amount of protein was produced *i.e.* 7.90 µg/ml followed by day 3 (7.27 µg/ml) respectively. However, the quantity of protein reduced drastically on day 5 with mean quantity of 4.71µg/ml.

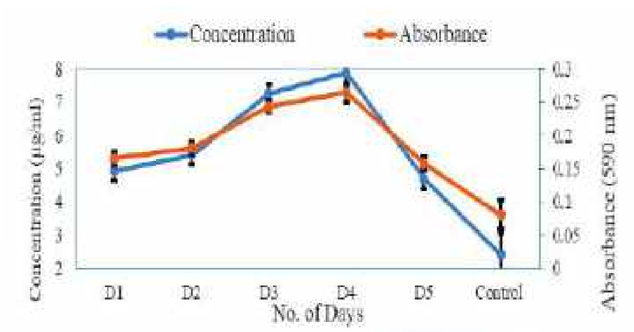


Fig. 4.3.3. Kinetics of proteinaceous toxin production by *Alternaria alternata* strain VLH1

The crude protein extract isolated by ammonium sulphate precipitation method was used to treat two major sucking pests, wheat aphid (*Sitobion avenae*) and mustard aphid (*Lipaphis erysimi*). The LC_{50} values of 127.06 ppm and 74.47 ppm were recorded against the two aphid pests, respectively (Table 4.3.2.)

Table 4.3.2. *In-vitro* Bioassay with crude protein against major sucking pests of *rabi* crops

Insect Species	Linear equation (Y=ax+c)	Protein concentration (in ppm)		χ^2 value
		LC_{50}	LC_{90}	
Lipaphis erysimi	Y=0.94x+3.24	74.47	1713.95	0.87
Sitobion avenae	Y=1.25x+2.37	127.06	1324.77	0.89

Species delimitation of shoot flies infesting cereals and millets

A low cost shoot fly trap was developed using rotten fish as a lure and trapped shoot flies were characterized using mitochondrial cytochrome oxidase (mtCOI) gene primer. The trap was installed in rice, wheat, maize, barley, finger millet and barnyard millet. The details of the species identified through BLASTn analysis and NCBI data bases are furnished in Table 4.3.3.

Low cost shoot fly trap

Table 4.3.3. Shoot fly species infecting different cereal and millet crops

Crop	Shoot fly species
Rice	*Atherigona varia, Botanophila fugax*
Maize	*Atherigona theodori, A. varia*
Wheat	*A. theodori, A. varia, A. orientalis*
Barley	*Atherigona varia, A. bidens*
Finger millet	*Atherigona varia*
Barnyard millet	*Atherigona varia, A. theodori,*

Bio-efficacy of commonly used insecticides against aphid pests

A total of 6 insecticides (Thiomethaxam, Imidacloprid, Indoxacarb, Pymetrozine, Nimbicidine, NSKE) were tested against field populations of cabbage aphid (*Brevicoryne brassicae*) and mustard aphid (*Lipaphis erysimi*). Thiomethaxam 25 WG was the most toxic insecticide against *L. erysimi* and *B. brassicae* with LC_{50} of 2.54 ppm and 0.024 ppm, respectively. While NSKE was least toxic insecticide with LC_{50} value of 9.55 ppm and 3.31 ppm respectively (The details of median lethal concentration are furnished in Fig. 4.3.4. and 4.3.5.).

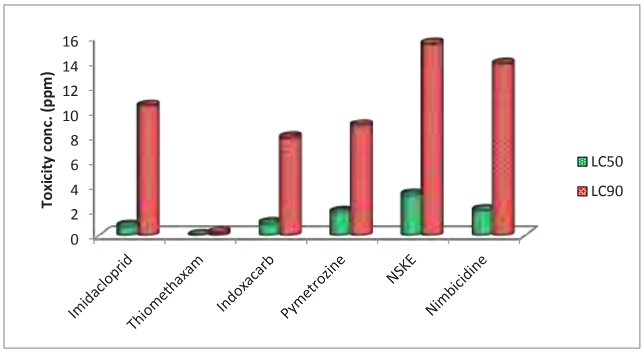


Fig. 4.3.4. Toxicity of selected insecticides against field populations of *Brevicoryne brassicae*

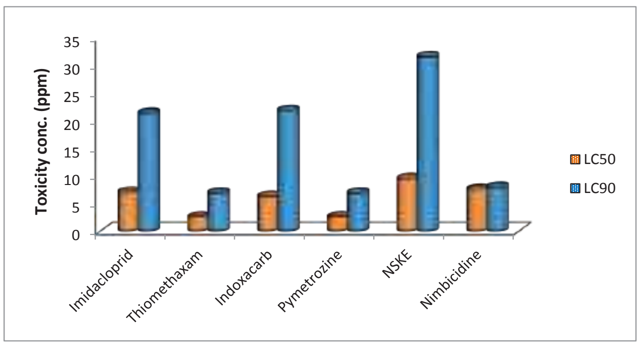


Fig. 4.3.5. Toxicity of selected insecticides against field populations of *Lipaphis erysimi*

Toxicity of diamide insecticides against Helicoverpa armigera

Toxicity of three diamide group insecticides was tested against field population of *Helicoverpa armigera* from experimental farm, Hawalbag (LC_{50} and LC_{90} values furnished in Fig. 4.3.6.). Chlorantraniliprole18.5% SC was found to be highly toxic against *H. armigera* and recorded the lowest LC_{50} and LC_{90} values of 162.18 and 549.54 ppm, respectively. However, Flubendiamide 39.35% SC was the least toxic insecticide with highest LC_{50} and LC_{90} values of 2818.38 and 28183.2 ppm, respectively.

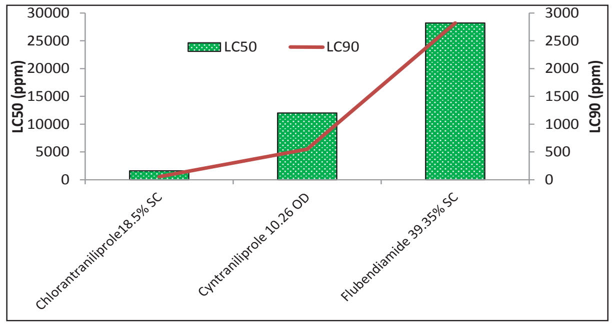


Fig. 4.3.6. Toxicity of diamide insecticides against field populations of *Helicoverpa armigera*

4.4. Studies on Physico-Chemical Properties of Compost and Casing Soil in Relation to Fructification and Yield of White Button Mushroom (*Agaricus bisporus*)

Effect of siderophore producing Pseudomonas strains on yield of Agaricus bisporus

A total of 12 siderophore producing *Pseudomonas* strains were evaluated for enhancing yield of *Agaricus bisporus* (Fig. 4.4.1.). The strain PGP4 *i.e.* *Pseudomonas* sp. NARs9 gave significantly higher yield (1015 g/08 kg compost) as compared to untreated control (710 g/08 kg compost).

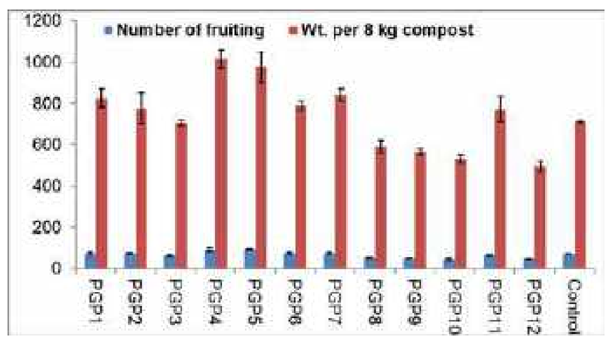


Fig. 4.4.1. Response of siderophore producing *Pseudomonas* strains on yield of *A. bisporus*

{PGP1=*P. lurida* NPRs3, PGP2=*P. lurida* NPRp15, PGP3=*P.* sp. NARs1, PGP4=*P.* sp. NARs9, PGP5=*P.* sp. PPERs23, PGP6=*P.* sp. PCRs4, PGP7=*P. jessenii* PGRs1, PGP8=*P. putida* PGR4, PGP9=*P.* sp. PGERs17, PGP10=*P. putida* PBRs7, PGP11=*P. koreensis* PBRs7, PGP12=*P. fluorescens* PPRs4, PGP13= Uninoculated control}

Evaluation of siderophore producing Pseudomonas strains on yield of Agaricus bisporus

Thirteen siderophore producing and 'P' solubilizing *Pseudomonas* strains were applied in casing soil whereas, un-inoculated bags were kept as control. Strain P1 (*P. fragi* CS11RH1), P3 (*P. fragi* CS11RH4) and P12 (*P. poae* NS12RH2) gave numerically higher yield (1011.3 g, 973.75 g and 998.75 g per 08 kg compost, respectively) in comparison to untreated control (948.75 g/08 kg compost) (Fig. 4.4.2.).

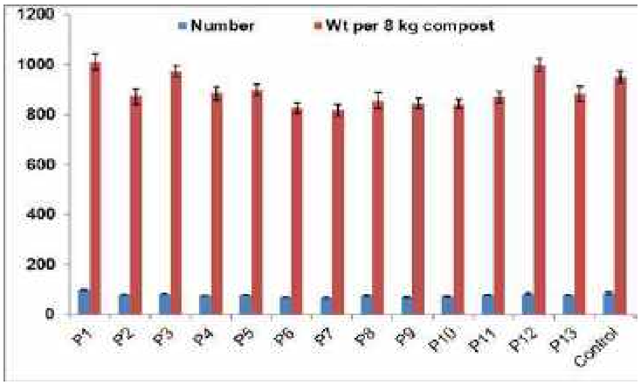


Fig. 4.4.2.. Response of P solubilizing *Pseudomonas* strains on yield of *A. bisporus*

{P1=*P. fragi* CS11RH1, P2=*Pseudomonas* sp. CS11RP1, P3=*P. fragi* CS11RH4, P4=*P* sp. CT4RH2(2), P5=*P.* sp. RT5RP(2), P6=*P.* sp. RT6RP, P7=*P.* sp. PB2RP2, P8=*P.* sp. PB2RP1(1), P9=*P.* sp. PB1RP3, P10=*P.* sp. PCRP7(2), P11=*P. poae* PB2RP1(2), P12=*P. poae,* NS12RH2(1), P13=*P. lurida* M2RH3, P14= Uninoculated control}

Effect of siderophoire producing bacterial consortia on yield of Agaricus bisporus

Eight siderophore producing and 'P' solubilizing bacterial consortia were applied to enhance yield of *Agaricus bisporus* (button mushroom) along with uninoculated control (Fig 4.4.3.). Results showed that application of consortium C4 (CS11RH1, CS11RP1, CS11RH4) gave significantly higher yield (1.87 kg/08 kg compost) in comparison to control (1.35 kg/08 kg compost).

Effect of PGP siderophore producing bacterial consortia on yield of A. bisporus

Eight different plant growth promoting siderophore producing bacterial consortium were evaluated to increase A. bisporus yield (Fig. 4.4.4.). The consortium C1 (PGERs17, NARs9, PPERs23) gave significantly higher yield (1040 g) in comparison to untreated control (653.3 g).

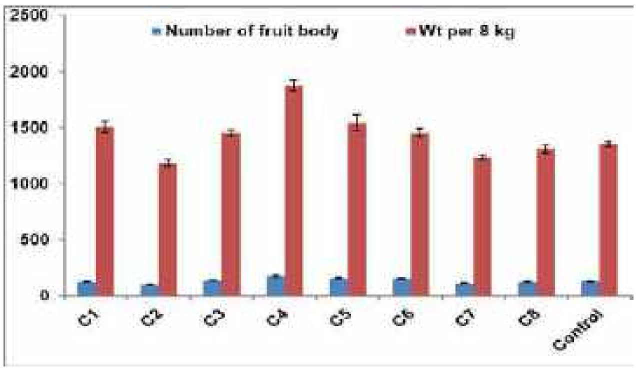


Fig. 4.4.3.. Response of different bacterial consortium on yield of A. *bisporus*

{C1=CS11RH1, PB2RP1(2), NS12RH2 (1); C2=PB2RP1 (2), NS12RH2(1), CS11RP1; C3=PB2RP1 (2), NS12RH2(1), CS11RH4;C4= CS11RH1,CS11RP1, CS11RH4;C5= CS11RH1 ,NS12RH2(1), CS11RP1; C6=CS11RH1, CS11RP1,PB2RP1(2); C7=CS11RP1, CS11RH4, PB2RP1(2); C8=CS11RH4, CS11RH1, PB2RP1(2); C9= Uninoculated control}

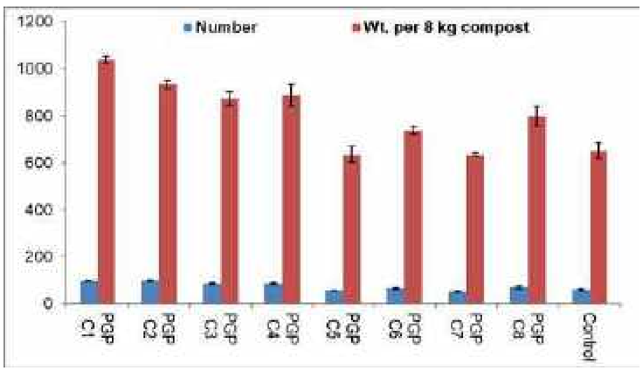


Fig. 4.4.4. Response of PGP siderophore producing bacterial consortia on yield of A. bisporus

{C1=PGERs17, NARs9,PPERs23; C2=PGRs4, PPERs23, PCRs4; C3=PBRs7, PCRs4, PGRs1; C4=PPRs4, PCRs4, PGRs1; C5=PPRs4, NARs9, PPERs23;C6=PGRs4, PCRs4, PPRs4; C7=PPRs4, NARs9, PBRs7; C8=PPRs4, NARs9, PPERs23; C9=Uninoculated control}

5. Socio-Economic Studies, Transfer of Technology and Information Technology

Research Projects

- Impact of Constrained and Unconstrained Choices on Adoption of Improved Agricultural Practices by Farmers *[Drs. Renu Jethi & Kushagra Joshi]*
- Technological Interventions for Mitigating Drudgery and Improving Nutritional Status of Hill Farmwomen *[Drs. Kushagra Joshi & Renu Jethi]*

5. Socio-Economic Studies, Transfer of Technology and Information Technology

Socio-Economic survey and analysis are important aspects of any developmental activity. Analysis of socio-economic conditions is not only the basis of successful transfer of technologies but also provides inputs for refinement of research activities to develop economically viable and farmer friendly agro-technologies.

5.1. Impact of Constrained and Unconstrained Choices on Adoption of Improved Agricultural Practices by Farmers

The present study was undertaken to find out the effect of improved agricultural technology (improved variety and line sowing with recommended plant spacing) on productivity, farmers' preferences for crop variety traits, farmers' preferences for line sowing (Table 5.1.1).

Table 5.1.1: Experimental treatments of crop production practices at farmers' field

Treatment I	Improved variety with line sowing
Treatment II	Improved variety with farmers' practice
Treatment III	Farmers' variety with farmers' practice

Farmers' preferences for varietal traits in finger millet

The study was carried out in two villages (Baitholi & Kiroli) of Pithoragarh district. Demonstration of improved variety (VL *Mandua* 352) was conducted in 1.0 ha area with 40 farmers. Equal number of farmers performed line sowing and broadcasting as a method of sowing. The participatory on-farm evaluation and demonstration of different production practice were conducted. The treatments were arranged in un-replicated simple block considering farmers as replications. Data was collected employing checklists and focus group discussion (FGD). Farmers were provided with checklist of crop varietal traits. Each respondent was asked to make their choices. On the basis of their choices, preference score was computed for finger millet variety (Fig. 5.1.1.).

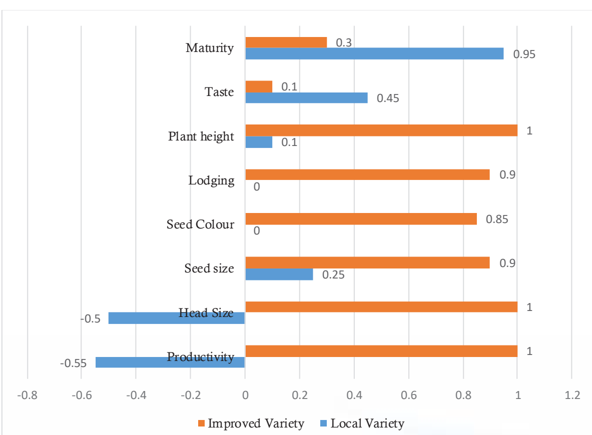


Fig. 5.1.1. Preference analysis of varietal traits in finger millet

The crop variety attributes used in the choice experiment include yield level (productivity), head size, seed size, colour, lodging, plant height, taste and maturity. It was found that preference score for improved variety (VL *Mandua* 352) was more than the local variety in attributes, *viz*. productivity (1), head size (1), seed size (0.9), seed colour (0.85), lodging (0.9) and plant height (1), whereas, preference score related to attributes like taste (0.1) and maturity (0.3) was less than the local variety.

Farmers' preferences in lentil crop production practices

Demonstration of improved variety (VL *Masoor* 126) was conducted in 1.0 ha area with 40 farmers. Equal number of farmers performed line sowing and broadcasting as a method of sowing. Tally method was used in which the first, second, third, fourth, fifth and sixth ranking has weighted values of 6, 5, 4, 3, 2 and 1, respectively. Then weighted ranking matrix table was constructed. Under lentil crop, based on the overall preference

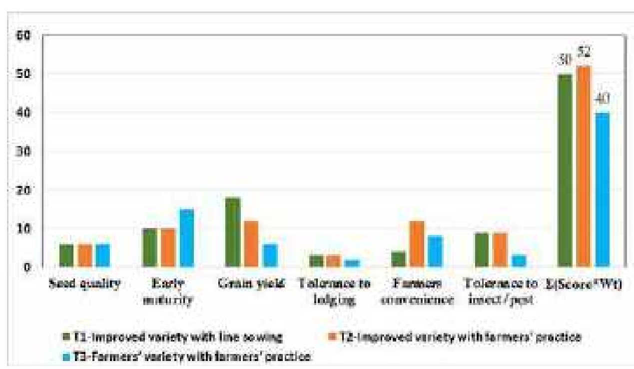


Fig. 5.1.2. Farmers evaluation criteria and preference ranking in lentil

criteria, treatment 1 (improved variety along with line sowing) was preferred by farmers with total score of 41 when farmers convenience was not considered. Whereas treatment 2 (improved variety along with broadcasting) was preferred by farmers when farmers convenience with weight 4 was also considered (total score 52) in lentil crop (Fig. 5.1.2.).

Farmers' preferences for varietal traits in lentil

The crop variety attributes used in the choice experiment for lentil crop include yield level (productivity), disease resistance, seed quality and maturity. It was found that preference score for improved variety (VL *Masoor* 126) was more than the local variety in attributes, *viz*. productivity (0.95), disease resistance (0.9). Farmers preferred both the varieties equally for seed quality, whereas, preference score related to maturity (-0.1) was less for improved variety.

Line sowing in lentil field

Farmers' preferences in wheat crop production practices

Under wheat crop, based on the overall preference criteria, treatment 1 was preferred by farmers with total score of 58 when farmers convenience was not considered, whereas treatment 2 was preferred by farmers when farmers convenience was also considered (total score 77) (Fig. 5.1.3.).

VL *Gehun* 953 with line sowing at farmers field

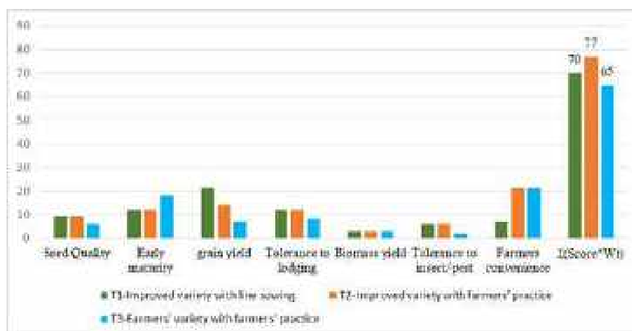


Fig. 5.1.3. Farmers' evaluation criteria and preference ranking (Wheat Crop)

Attributes of local and improved lentil varieties

Yield analysis under different treatments

Improved lentil variety VL *Masoor* 126 yielded 1,040 kg/ha and 950 kg/ha under T1 and T2, respectively. Yield of VL *Masoor* 126 under T1 was 9.5 percent higher than T2. Farmers local lentil variety yielded 650 kg/ha. Similarly, improved wheat variety VL *Gehun* 953 yielded 3,650 kg/ha and 3,400 kg/ha under T1 and T2, respectively. Yield of *Gehun* 953 under T1 was 7.3 percent higher than T2. Farmers local wheat variety yielded 2,750 kg/ha.

5.2. Technological Interventions for Mitigating Drudgery and Improving Nutritional Status of Hill Farmwomen

Food based approach for improving nutritional status of farmwomen

Using Minimum Dietary Diversity Scores for women, a proxy-indicator for micro-nutrient deficiency among women, the dietary scores of women were found less than 5. The women attaining low scores on knowledge, attitude and practices towards nutrition and occupational health and low dietary diversity scores were selected for the intervention. Based on nutritional status and dietary diversity scores of farm women, concept of Homestead Nutrition gardens (68) as food-based approach was promoted in Takula and Hawalbagh block of Almora district. Besides, trainings on food preparation and value addition of cereals were provided to give food choices to farm women at frequent times. Women farm school was organised to provide training on homestead nutrition garden, drudgery reducing tools, selection of hand tools, good posture, diets and nutritional deficiencies.

Effect of food based intervention approach on nutritional status and dietary diversity of farm women

The homestead vegetable gardens varied from 50 to 100 m^2 area catering the needs of a family of 5 members, producing vegetables round the year. The women were provided seasonal vegetable calendars as a learning tool to choose vegetables to be grown round the year. As a result the year round availability of vegetables increased, fulfilling the requirement of vegetables (fruit based, roots and tubers and green leafy vegetables) as per ICMR standards (Fig. 5.2.1. a & b). The change in dietary diversity scores was observed and about 75% women could achieve mean dietary diversity score *i.e.* atleast inclusion of 5 types of foods in their daily diets (Fig. 5.2.2.).

Glimpse of farm women school

Hands on training on homestead nutrition gardening

Distribution of seed kits for nutrition gardens

Demonstration on food variety choices: soya tofu and milk preparation

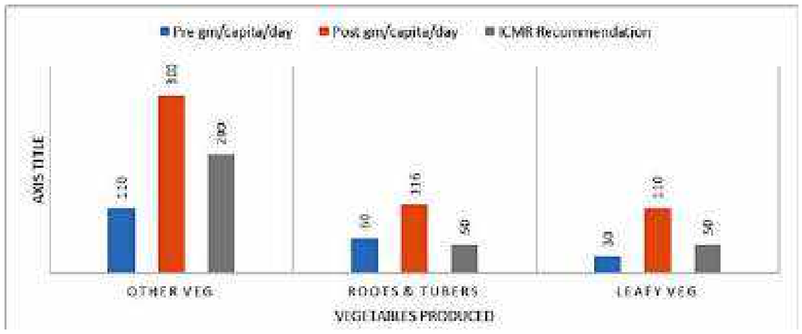


Fig. 5.2.1a. Comparative potential of availability of three types of vegetables (pre and post-garden intervention

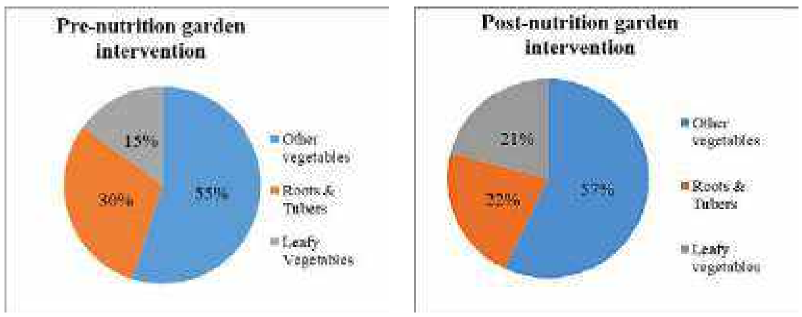


Fig 5.2.1b. Year round availability of vegetables pre and post-intervention

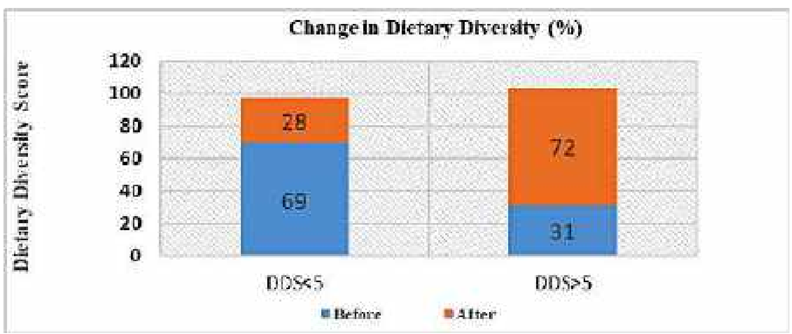


Fig. 5.2.2. Change in dietary diversity scores of beneficiary farm women after the intervention

Testing of technologies for women farmers as drudgery reducing alternatives to conventional practice

Some technologies were tested for drudgery reduction in participatory mode using ergonomic techniques. A three-row paddy transplanter was tested with women farmers in Binta village of Almora district. Heart rate, energy expenditure rate and psycho-physical experiences of farm women operating the transplanter were recorded (Table 5.2.1. & 5.2.2.).

The Rapid Entire Body Analysis technique revealed that the three-row transplanter significantly

Table 5.2.1. Psychophysical analysis of worker's perception on three row transplanter and conventional practice

Psycho-physical Parameter	Manual transplanting	Paddy transplanter	Change (%)	p-value
Overall Discomfort Rating, ODR	7.9 ± 1.09 (More than moderate discomfort)	4.15 ±0.65 (Mild discomfort)	47.80	<0.01
Rated Perceived Exertion, RPE	9.47± 0.59	1.22 ± 0.76	87.11	<0.01
REBA Score	9.32	6.23	33.15	<0.05

Table 5.2.2. Ergonomic evaluation of three row paddy transplanter in comparison to manual transplanting

Ergonomic Parameters	Manual Transplanting	Paddy transplanter	Per cent Change	p-value
Working Heart Rate (beats/min)	121.20	128.00	-4.00	NS
Energy Expenditure Rate (kJ/min)	10.55 (Heavy)	11.63 (Heavy)	-10.20	NS
Area covered (ha/hr)	0.03	0.08	166.00	<0.0001

Transplanting with three row transplanter and manual transplanting by farm woman

reduced the discomfort perceived and exertion reported by the farm women while transplanting paddy nursery in comparison to the conventional method. The postural discomfort also reduced significantly by use of the transplanter.

There was no significant difference in energy expenditure of farm women but more area was covered in same time by use of transplanter in comparison to the manual practice. Exertion levels were also reduced significantly (87%). Reduction in Overall Discomfort Rate (ODR) score also implies that the use of trasnplanter may ease the discomfort due to posture adopted in manual transplanting.

Participatory evaluation of weeding with long handled hoe and local kutla

In finger millet, weeding is a tiresome and monotonous work which is women dominant and time consuming. The VL long handle hand hoe was tested with farm women for drudgery reduction in weeding in finger millet (Fig. 5.2.3.).

It was found that the use of hand hoe with long handle reduced the energy expenditure of women while weeding by 12% and the work pulse by 24%, suggesting that the long handled hoe can be promoted in hill areas for weeding in finger millet

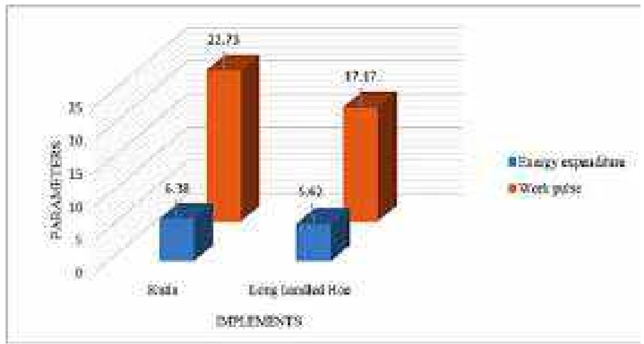


Fig. 5.2.3. Ergonomic evaluation of VL long handled hand hoe and conventional *kutla* in weeding finger millet

Testing of VL Long handled hoe with farmwoman

for making the activity less drudgery prone.

Ergonomic evaluation of VL wheat thresher for threshing wheat

Wheat threshing is an activity which requires women to be seated for hours, atleast 4 or 5 hours a day for beating the wheat with a wooden plank.

During wheat threshing, energy expenditure of women is reduced by 20% using VL Wheat thresher in comparison to manual threshing. Manual wheat threshing, which is a moderately heavy activity to perform (EER:8.8 kJ/min), can be changed to a light activity (EER: 7 kJ/min) to perform by use of VL Wheat thresher, thus reducing physiological stress of farmer (Table 5.2.3.).

Table 5.2.3. Reduction in energy expenditure rate in threshing of wheat by VL thresher in comparison to manual threshing

Parameters	VL Thresher	Manual threshing	Change (%)
Energy Expenditure rate, EER (kJ/min)	7 (Light)	8.79 (Mod heavy)	19.34
Rated Perceived Exertion	3.6	4.2	14.28

Threshing wheat manually

Threshing by VL Wheat Thresher

Demonstration of line sowing in wheat at farmers field

6. Other Research Projects

6.1. ICAR-NASF Funded

- Utilization and Refinement of Haploid/Doubled haploid Induction Systems in Rice, Wheat and Maize Using *In-vitro* and Molecular Strategies *[Drs. R.K. Khulbe & A. Pattanayak]*

6.2. National Food Security Mission (NFSM) Funded

- Enhancing Breeder Seed Production to Increase Indigenous Production of Millets in India *[Dr. Dinesh Chandra Joshi]*

6.3. Consortium Research Platform (CRP) Projects

- ICAR-CRP on Biofortification in Selected Crops for Nutritional Security *[Drs. R.K. Khulbe, R.S. Pal & Rakesh Bhowmick]*
- ICAR-CRP on Molecular Breeding in Maize *[Drs. R.K. Khulbe, R.S. Pal, Rajashekara, H. & Rakesh Bhowmick]*
- CRP on Agrobiodiversity, PGR Management, Component II – Wheat *[Drs. Lakshmi Kant & K.K. Mishra]*
- CRP on Molecular Breeding Wheat *[Drs. Lakshmi Kant, K.K. Mishra & Rakesh Bhowmick]*

6.4. UN Environment - GEF Project

- Mainstreaming Agricultural Biodiversity Conservation and Utilization in Agricultural Sector to Ensure Ecosystem Services and Reduce Vulnerability *[Drs. A. Bhartiya, Kushagra Joshi & Jitendra Kumar]*

6.5. PVP & DUS Test Through ICAR-SAU System

- DUS/GOT trials in kidney bean *[Dr. Anuradha Bhartiya]*

6.6. DBT Funded Project

- "Integrated Genomic Strategy for accelerating domestication of Ricebean" *[Dr. D.C. Joshi]*
- Collection and Characterization of Indigenous Shiitake (*Lentinula edodes)* and DNA Barcoding of Oyster *(Pleurotus* spp.*)* Mushroom Germplasm for Commercial Exploitation *[Dr. K. K. Mishra]*

6.7. AICRP/ Network Projects

- Use of Plastics in Agriculture Particularly in Protected Cultivation, Water Harvesting and Packaging (AICRP on PEASEM) *[Drs. Jitendra Kumar (PI since 30 May 2020), Sher Singh (PI upto 29 May 2020 & Co-PI since 30 May 2020), Shyam Nath (Co-PI) and Er. Utkarsh Kumar (Co-PI since 01 April 2020)]*
- Post Harvest Technology for Value Addition and Marketing of Agricultural Produce (AICRP on PHET) *[Drs. Shyam Nath (PI since 09 Jul 2020), Dr. Sher Singh (PI upto 08 Jul 2020 & Co-PI since 09 Jul. 2020), Dr. Kushagra Joshi (Co-PI), Er. Jitendra Kumar (Co-PI) & Dr. J.K. Bisht (Associated Scientist)]*
- All India Network Project on Soil Arthropod Pests *[Drs. A.R.N.S. Subbanna & Amit Paschapur]*

- Network Programme on Organic Farming (NPOF) *[Drs. Dibakar Mahanta, P.K. Mishra, K.K. Mishra, A.R.N.S. Subbanna, V.S. Meena (upto May 26, 2020), Manoj Parihar & Priyanka Khati (on maternity/child care leave)]*
- All India Coordinated Research Project on Mushroom *[Dr. K.K. Mishra]*

6.8. Network Project on AMAAS

- Developing PGPR Consortia for Enhanced Micronutrient (iron and zinc) Uptake and Yield of Finger Millet (*Eleusine coracana*) in Hilly Areas *[Drs. Pankaj K. Mishra & V.S. Meena (on deputation w.e.f., May 26, 2020)]*

6.9. NICRA Project under Competitive Grants Component (CGS)

- Design & Development of Protective Structures for High Values Crops to Reduce Damage from Hail and Frost *[Dr. Sher Singh]*

6.10. National Mission on Himalayan Studies (NMHS) Project

- Strategies to Improve Health and Nutriotional Status of Hill Farm Women through Technological Interventions *[Drs. Renu Jethi, Pankaj Nautiyal & Pratibha Joshi]*
- Characterization of Kidney Bean (*Rajmah*) Rhizosphere Microbiome from Higher Altitude of Indian Central Himalaya *[Dr. Pankaj K. Mishra]*

6.11. National Mission for Sustaining the Himalayan Ecosystem (NMHSE)

- National mission for Sustaining the Himalayan *[Drs. A Pattanayak, S.C. Pandey, Kushegra Joshi & V.S. Meena (on deputation w.e.f., May 26, 2020)]*

High Altitute Testaing Site (HATS), Mukteshwar

- High Altitude Testing Site, Mukteshwar *[Drs. N.K. Hedau & Sher Singh]*

6.1. ICAR-NASF Funded Project

6.1.1. Utilization and Refinement of Haploid/ Doubled Haploid Induction Systems in Rice, Wheat and Maize Using *In-Vitro* and Molecular Strategies

Identification of promising chromosome doubling treatments

The treatments {APM 20 ppm + Trifluralin 1 ppm for 8 hrs (55.5 per cent); APM 20 ppm + Pronamide 1 ppm for 12 hrs (40.6 per cent) & Colchicine 400 ppm for 12 hrs (65.1 per cent) were found promising compared to the control Colchicine. These treatments will be re-evaluated during *kharif* 2021 for identification of the most effective treatment combination.

Identification of seed marker for haploid classification

The putative haploid seed from the cross V 405 x TAILP1 and CMVL 55 x TAILP1 were raised during *kharif* 2020 to assess the efficiency of haploid selection based on kernel dorsal basal pigmentation. The efficiency of the selection method was found to be 82.6%. Haploid seed of the cross have been generated again for confirmation of the results during *kharif* 2021.

DH production aimed at consolidation/accumulation of multi-trait marker tagged genes in elite backgrounds

- During *kharif* 2020, 159 DH lines (High Tryptophan + High Provitamin A) were raised and about 20 DH lines with good agronomic attributes were identified for use in hybrid development programme for development of biofortified maize hybrids.
- Four new source populations for production of triple-trait DH lines (High Tryptophan + High Provitamin A + Low phytate) will be generated during *rabi* 2020-21 (at ICAR-IIMR Winter Nursery Centre, Hyderabad) and used for DH generation during *kharif* 2021

Ears of promising high tryptophan + high provitamin A DH lines derived from Pusa *Vivek* QPM 9 Improved (left) and MTC-2 (right)

Up-scaling of double haploid (DH) maize programme

- More than 800 doubled haploid lines of normal corn, sweet corn and biofortified maize (QPM/ high Provitamin A/low phytate) generated during *kharif* 2019 were raised during *kharif* 2020 and promising DH lines were identifed.

Ears of normal corn (left) and sweet corn (right) DH lines generated from public and private sector hybrids

- Selfed seed was harvested from about 1300 diploidized haploid plants obtained from induction crosses generated during *kharif* 2019 which are expected to yield 1100-1200 new DH lines during *kharif* 2021.
- Eight new induction crosses involving normal corn, sweet corn and biofortified inbreds have been generated during *kharif* 2020 for production of new DH lines during *kharif* 2021.

6.1.2. Development/Identification of Genetic Resources

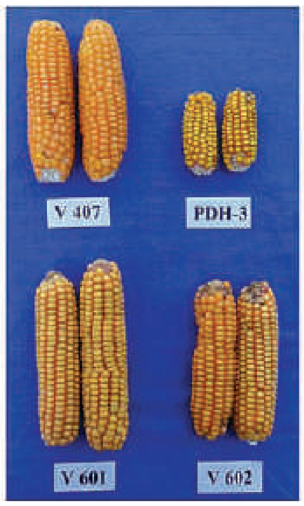
Development of liguleless stocks

Liguleless maize genotypes are characterized by the absence of ligule and auricle in the leaf sheath

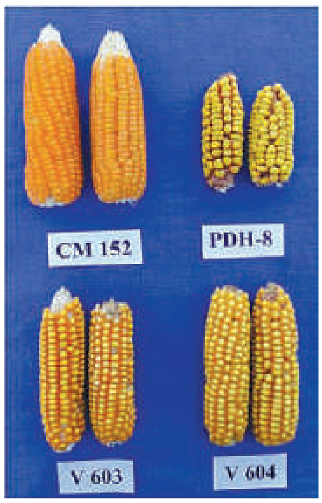
a. Normal b. Liguleless

which results in smaller leaf angle and thereby more upright leaves compared to normal maize genotypes (a-b). Liguleless trait can be phenotyped at seedling stage, which makes liguleless genotypes (carrying recessive genes *lg1* or *lg2*) amenable for genetic studies such as gene-editing 'proof-of-concept' demonstration and haploid induction rate (HIR) assessment.

Indigenous liguleless stocks are not available in Indian public maize breeding programme. Liguleless lines PDH-3 and PDH-8 were obtained from University of Hohenheim, Germany and crossed with inbred V 407 and narrow-base population CM 152 with the objective of transferring the trait into locally adapted background. On the basis of their agronomic superiority compared to the donor stocks (c & d, Table 6.1.1.), four liguleless F_5 generation lines (VL 601, VL 602, VL 603 and VL 604) were identified for further maintenance and use.



c. Liguleless stocks V 601 and V 602



d. Liguleless stocks V 603 and V 604

Identification of line with >40 per cent haploid fertility (HF)

Haploid plants in maize are expected to be sterile due to abnormal meiosis and, as a result, no seed setting upon self-fertilization. However, due to spontaneous chromosome doubling in haploids, haploid fertility was ranged 0 to 70% in maize germplasm.

a. Sterile haploid

b. Fertile haploid

Table 6.1.1. Characteristics of liguleless lines V 601, V 602, V 603, V 604 and their parents

Characters	PDH-3	V 407	V 407 x PDH-3		CM 152	PDH-8	CM 152 x PDH-8	
			V 601	V 602			V 604	V 603
Days to 50% pollen shed	49	53	51	52	48	47	48	48
Days to 50% silking	50	55	52	54	49	48	48	49
Plant height (cm)	165	135	170	185	145	120	135	150
Ear height (cm)	90	70	95	95	80	40	55	60
Days to 75% brown husk	86	91	88	90	85	85	84	86
Cob length (cm)	8.4	15.8	17.4	15.8	14.3	11.4	14.3	13.3
Cob girth (cm)	10.5	14.8	13.5	13.2	14.3	10.6	12.8	12.0
Kernel rows	12-14	14-16	10-12	12-14	12-14	10-12	12-14	12-14
Grains / Row	16.0	23.0	26.0	26.0	29.0	20.0	23.0	21.0
100-seed wt.	160	302	280	265	245	215	240	225
Cob wood colour	Light red	White	Light Red	Red	White	Dark red	Red	White
Grain type	Yellow Dent	Orange Flint	Yellow Dent	Yellow with slight dent	Orange Yellow Flint	Yellow Dent Chalky	Yellow Dent	Yellow Dent
Turcicum leaf blight (1-5)	2.75	1.75	2.00	3.00	2.00	3.00	2.00	2.00
Maydis leaf blight (1-5)	3.00	2.00	2.00	2.75	2.00	2.75	2.75	2.50
Common rust (1-5)	3.50	2.00	2.50	2.00	1.75	3.50	3.00	3.00

Selfed ears from fertile haploid plants

During *kharif* 2020, haploid seed of 13 inbred lines was raised to assess haploid fertility in the lines. Haploid fertility among the lines ranged from 0 to 42.9% with the line VDH 605 exhibiting the highest fertility. The fertile haploid plants of VDH 605 were selfed and the seed collected. A larger population of haploid plants will be raised during *kharif* 2021 for confirmation of HF percentage in the line. The line VDH 605 will be an important genetic resource for haploid fertility related studies in maize.

6.2. National Food Security Mission (NFSM) Funded

6.2.1. Enhancing Breeder Seed Production to Increase Indigenous Production of Millets in India

During *kharif* 2020, a total of 2.2 q of breeder seed of three promising small millet varieties were produced.

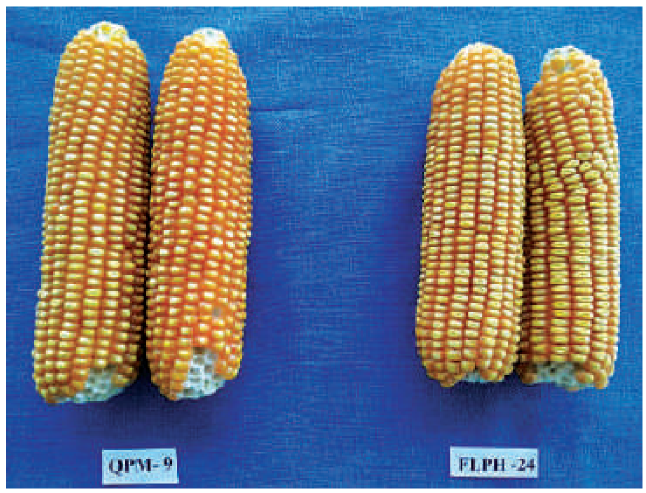
Crop	Variety	Quantity (quintal)
Finger millet	VL *Mandua* 380	1.0
Barnyard millet	VL *Madira* 207	0.6
Barnyard millet	VL *Madira* 172	0.6
Total		**2.2**

VL *Mandua* 380

6.3. Consortium Research Platform (CRP) Projects

6.3.1. ICAR-CRP on Biofortification in Selected Crops for Nutritional Security

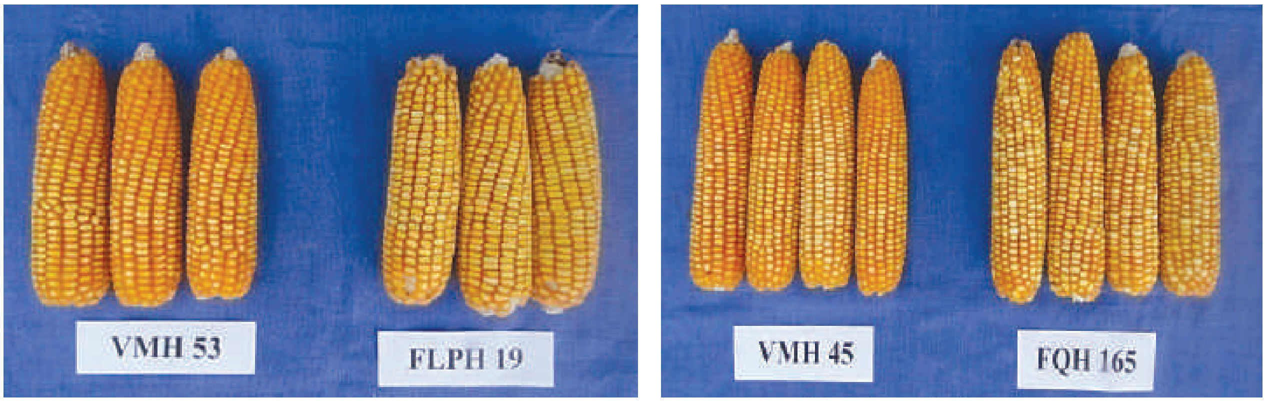
Thirty nine F_7 lines of four crosses between elite QPM lines (VQL 1, VQL 2, VQL 17 and VQL 373) and low phytate donor Lpa 2 were raised at Almora during *kharif* 2020 for agronomic and biochemical evaluation. Agronomically superior lines (high vigour, good ear size, tolerance/resistance to turcicum leaf blight) were identified. The identified lines will be biochemically evaluated and lines carrying the desired trait combination [high tryptophan (>0.6%) + low phytate (<2.5 mg/g)] will be maintained. Twelve new crosses were generated among the selected lines. The previously generated hybrid FLPH 24 is under evaluation in AICRP and SVT during *kharif* 2020.



Mature cobs of VQPM 9 and FLPH 24

6.3.2. ICAR-CRP on Molecular Breeding in Maize

Selected BC_2F_5 lines derived from crosses between trait specific donors and their respective recipient lines [QPM (V 407/VQL 373), β-carotene (V 400/ CIMMYT 4 and V 412/CIMMYT 13) and low phytate (V 409/LPA 2 and V 407/LPA 2)] were raised during *kharif* 2020 at Almora. Individual plants were screened with suitable foreground markers (umc1006 and phi057 for high tryptophan, crtRB1 for high β-carotene and umc 2230 for low phytate). Seed of selected lines was maintained.



Mature cobs of FQH 165 and FLPH 19 along with their respective original hybrids

FQH 165 (QPM version of VMH 45), FLPH 19 (low phytate version of VMH 53) and high provitamin A hybrid FPVH 1 are under evaluation in AICRP and SVT during *kharif* 2020. For the second phase of the project, F_1s between the parental inbreds of CMVL 55 (V 407/V 405) and VLMH 57 (V 412/V 433) and waxy donor (Pusa Waxy) are being generated for developing high amylopectin versions of CMVL 55 and VLMH 57.

6.3.3. CRP on Agrobiodiversity, PGR Management, Component II – Wheat

Two hundred and forty nine wheat accessions inoculated for confirmation of loose smut resistance during *rabi* 2018-19 were sown in expression nursery. Among these 127 found free (0.0% infection) and 9 found resistant (0.1 to 5.0% infections) to loose smut. In addition 642 accessions were evaluated for expression, out of these 100 were free (0.0% infection) and 16 found resistant (0.1 to 5.0% infection) to loose smut. However, another set of 693 new accessions were inoculated during *rabi* 2019-20.

6.3.4. CRP on Molecular Breeding Wheat

Two popular wheat varieties *viz.,* VL *Gehun* 907 (timely sown condition) and VL *Gehun* 892 (late sown condition) has started showing susceptibility to the new races of yellow rust pathogen were selected to pyramid durable rust resistance genes *viz., Yr*10 and *Lr* 24. During *rabi* 2019-20, F_{4s} RILs [(VL *Gehun* 892/ Yr10/5*Datatine //VL *Gehun* 892), (VL *Gehun* 892/ FLW1//VL *Gehun* 892), (VL *Gehun* 907/ Yr10/5*Datatine //VL *Gehun* 907) and (VL *Gehun* 907/ FLW 1 //VL *Gehun* 907)] were planted at experimental farm, Hawalbag.

Field view of CRP molecular breeding materials

Field view of CRP agrobiodiversity materials

Susceptible accession

Resistant accession

Inheritance studies for transgenerational stress memory in wheat induced by late sowing

A total of 10 test entries having low and high test weights sourced from the *rabi* 2018-19 rainfed and irrigated trials, respectively were aggregated to constitute a 20 entry trial in four different dates of sowing (early, timely, late & very late) during *rabi* 2019-20 to find underlying transgenerational memorization for test weight. Based on the results obtained, test entries during early and timely sown trials, showed a significant difference for test weights attributed to last season's test weight differences with p values 0.01 and 0.04 ($p<0.05$), respectively. However, the preliminary result needs to be validated by multiyear data and hence experiment was repeated in *rabi* 2020-21.

6.4.UN Environment - GEF Project

6.4.1 Mainstreaming Agricultural Biodiversity Conservation and Utilization in Agricultural Sector to Ensure Ecosystem Services and Reduce Vulnerability

A total 96 landraces comprising barley (30), black soybean (21), horse gram (12), amaranth (21) and buckwheat (12) were evaluated in mother (5) and crowd sourcing (28) trials during *rabi* 2019-20 and *kharif* 2020.

Table 6.4.1. Identified landraces from crowd sourcing trials in target crops

Crop	Promising accessions
Barley	IC 047347, Local I & EC0578863
Black soybean	IC355881, IC 262069 &IC356479
Horse gram	IC 281677, IC 262106 & SK-RSM-MA-20
Amaranth	IC444100, IC 444105 & IC 266835
Buck wheat	VL Ugal 7, IC 266979 & IC 392556

Trials at farmer' field at village Govindpur, Almora

Seed of a total 198 landraces of 7 target crops comprising rice (36), black soybean (21), horse gram (27), amaranth (21) and finger millet (24) for utilizing in mother and crowd souring trials were multiplied during *kharif* 2021.

Seed multiplication of target crops at experimental farm, Hawalbag

Farmers (69) of target site were made acquainted with preparation of value added products like milk, *tofu*, nuggets of soybean/black soybean, *ragi namkeen* and farm implements & tools in exposure visits conducted during October 19-21, 2020 at experimental farm, Hawalbag, ICAR-VPKAS, Almora.

Crop and food diversity fair at Un Environment GEF Project site

A fair on traditional crop and food diversity was organized in village Mujholi, Almora under GEF project on Feb. 26, 2020. Total 41 women farmers participated in the event and prepared local recipes (approx. 100) of the region.

Traditional crop and food diversity fair at Mujholi village of Almora district

Characterization of farmers' varieties of target crops

A total 11 farmers' varieties of 4 target crops, *viz.* rice (*Lal Dhan, Kawthuni Dhan, Baurani Dhan, Dudh Dhan & Safed Dhan*), finger millet (*Garhwali, Golpahari & Nangchuni*), amaranth (*Safed Chua*) and black soybean (*Kala Chapta Bhat & Kala Mota Bhat*) have been purified with the help of farmers growing them.

Purification of finger millet FVs along with local farmers at ICAR-VPKAS, Almora

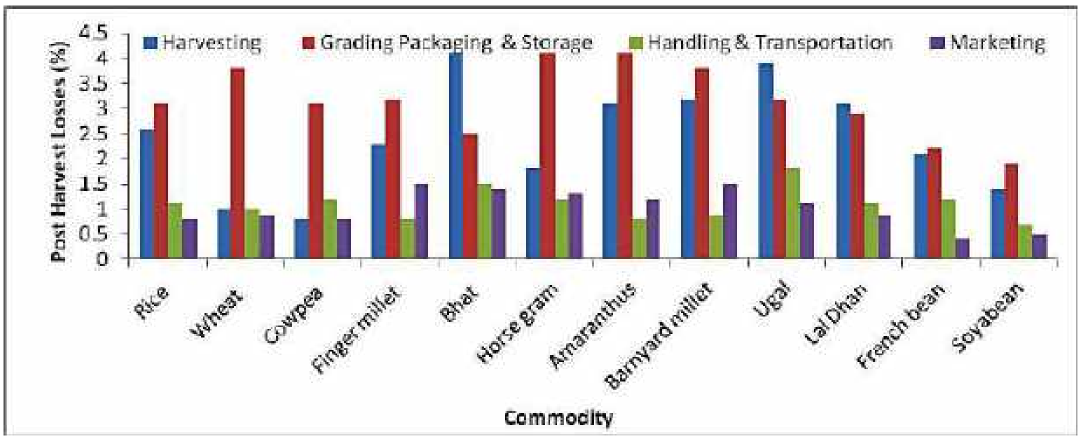


Fig. 6.4.1. Post harvest losses of different crops

Need assessment of farm tools and equipments

The need assessment of farm tools and equipments was done in target crops at selected site. It was observed that there is high need for introduction of small tools and implements *i.e.* VL Millet Thresher, Wheat thresher, VL Paddy thresher, Rice Transplanter, VL Solar Dryer, VL Vermi compost sieving drum and Improved primary tillage small tools developed by Institute. In order to address this problem, institute has distributed and demonstrated Vivek Millet Thresher-cum-Pearler (17 Nos.) during 2019-20, Improved VL Tools & implements (VL Small Tool Kit-51, Light Trap-7, VL Hal-14 and Agri-canon-7) were also distributed among farmers of project site on December 14, 2020.

Assessment of post harvest losses and farm mechanization status

The post harvest losses of different crops were estimated at the target site. The losses at field level have been estimated at harvesting, grading, packaging and storage, handling & transportation and marketing. The maximum post harvest losses was found in buck wheat (10%) followed by barnyard millet (9.4%), amaranth (9.2%), horse gram (8.8%), paddy (8%), black soybean (7.9%), finger millet (7.2%), wheat (6.7%), cowpea (6.1), french bean (5.9%) and soybean (4.5%) (Fig. 6.4.1.).

6.5. PVP & DUS Test Through ICAR-SAU System

Maize: One farmers' variety namely REG/2020/28 along with two reference varieties *viz.*, Vivek Maize Hybrid 53 and Vivek Maize Hybrid 57 were raised and characterized as per national guidelines for the conduct of test for DUS on maize during *kharif* 2020.

Silk and panicle of FV REG/2020/28

Maintenance breeding

In soybean 75 reference varieties were raised and multiplied. Whereas, in kidney bean two reference varieties VL *Rajma* 63 and VL *Rajma* 125 were grown for seed multiplication during *kharif* 2020.

6.6. DBT Funded Projects

6.6.1. Integrated Genomic Strategy for accelerating domestication of Ricebean

A total of 1680 accessions of rice bean were evaluated with four checks in augmented block design during *kharif* 2020. The data were recorded for 25 agro-morphological traits (Table 6.6.1.).

6.6.2. Collection and Characterization of Indigenous Shiitake (*Lentinula edodes*) and DNA Barcoding of Oyster (*Pleurotus* spp.) Mushroom Germplasm for Commercial Exploitation

A total of 08 *Lentinula edodes* strains were evaluated on substrate wheat straw for fructification during winter season. Out of 08 strains only 3 were fructificated and remaining 05 did not fructificate. Among 03 strains, strain Le 19-09 gave maximum yield *i.e.* 75.33 kg/100 kg dry substrate.

Table 6.6.1. List of promising accessions identified in rice bean germplasm collection

Trait	Range	Promising accessions
Seedling vigour	1-5 scale	IC-554713, IC-89632, IC-129078, IC-137159, IC-140801, IC-621844, IC-199549, IC-313494, IC-341951, IC-374603
Days to 50% flowering	65-95	IC-350152, IC-2074, EC-18566, IC-336485, EC-18771, IC-286105, IC-469199, IC-469207, IC-520896, IC-341914
Days to 80% maturity	100-150	LRB-140, EC-18556, IC-24199, IC-203946, IC-100195, IC-129085, IC-129092, IC-129093, IC-129099, IC-200059
Plant height (cm)	75.5- 150	IC-262747, IC-342218, IC-350152, IC-599884, IC-340341, IC-520898, IC-342233, IC-552988, IC-26972, IC-599885
Number of branches/ plant	2-8	IC-141073, IC-146230, IC-137183, IC-141071, IC-137142, IC-417831, IC-129093, IC-137133, IC-129053, IC-129085
Pod length (cm)	3.5-9.0	EC-269773, IC-350224, IC-351545, EC-16136, IC-521363, IC-73138-B, IC-144703, IC-26962, IC-26973, IC-26972
Number of pods/ cluster	5-16	IC-204097, IC-75447, IC-275988, IC-75448, IC-75462, IC-521114, IC-89648, IC-296532, IC-116125, IC-116128
Number of pods/plant	40-75	IC-116115, IC-116121, IC-129077, IC-129088, IC-129087, IC-129083, IC-129113, IC-129115, IC-137138, IC-129089
Number of seeds/pod	4-8	IC-129089, IC-129098, IC-129102, IC-137140, IC-137172, IC-137185, IC-140796, IC-141072, IC-141073, IC-146230

Phenotyping of rice bean germplasm and variation for pod size and colour

6.7. All India Coordinated Research Projects (AICRP)/ Network Projects

6.7.1. Use of Plastics in Agriculture Particularly in Protected Cultivation, Water Harvesting and Packaging (AICRP on PEASEM)

Development of solar cabinet dryer for hilly region

Institute has developed "VL Solar Dryer". The perishable, semi-perishable and non-perishable agricultural commodity/produce/food can be dried safely using solar thermal energy in a cleaner and healthier way. The "VL Solar Drier" has been developed using 2 mm thick transparent polycarbonate sheet. Its height and width is 900 and 600 mm (excluding Chimney & wheels) and light in weight (30 kg). Wheels have been provided at the base of solar drier to make it portable. A circulation chimney fitted with solar powered exhaust fan at the top of the drier. It has three perforated removable trays (lower, middle & upper) of different capacities along with basement. The trays are made of wood and 40 mess stainless steel net. The material is dried under hygienic conditions with zero operational cost. The drying capacity of the drier is 5 to 20 kg per batch depending on the type of produce. It can be used through out the year except cloudy weather. Since this is solar operated, the operational cost is nil. The cost of the "VL Solar Drier" is. Rs. 12,250/- (without packaging) and 12,750/- (with packaging) Technology is licenced to High Tech nurseries, Haldwani, Nainital on November 06, 2020.

VL Solar Drier

Dried product

Design and development of water lifting device for river bed cultivation

A water lifting device has been developed for river bed cultivation in hilly region. The developed water lifting device utilize the flow of water as source of energy for irrigating cropped area. Therefore, crop cultivation could take place under unirrigated area of river bed in hilly region. Two plunger pump assembly was used to pump water from river. River current with the help turbine was used as motive power to drive the pumps. Initially 14 numbers of blades were used in the turbine. The gear on the turbine drive shaft was of 14 teeth and the pump driven shaft was of 36 teeth. It was found that the discharge capacity of developed device was 10,580 litre/day at 9 m head and 45 m away from river source. This device will be most useful in areas where spring or gravitational flow of energy is available. It will help the farmers to get a better yield in erratic electricity availability at river-bed areas of hilly region.

Testing of water lifting device at Kosi river bed

Modelling of water and nutrient dynamics under mulch and drip irrigated cabbage crop

The effect of irrigation and fertigation frequency was evaluated on the growth and yield of drip irrigated cabbage (*Brassica oleraceae* var. *capitata* L.) crop under mulch system and includes three irrigation frequencies {N1 (once in a day), N2 (once in 2 days), N3 (once in 3 days)} and two levels of irrigation (100 & 80%) of crop evapotranspiration (ET_c) and fertigation treatment (100 and 80% of RDF). Water contents in various layers of root zone of crop in irrigation treatment at 48 h after irrigation varied from 16.5-22.7%. Soil matric potential varied from -25 to -65 kPa in different irrigation frequencies. Irrigation scheduled between -20 to -45 kPa had significant effect on cabbage growth and yield at 5% level of significance. Soil matric potential in the range of -27 to -34 kPa at 30 cm depth and irrigation frequency of once in two days can be used as an index for drip irrigation scheduling during cabbage growth period in sandy loam soils for attaining higher yields. Mulch cum drip irrigation frequency and irrigation levels significantly affects the crop yield. The maximum yield (38.9 t ha^{-1}) of cabbage crop was obtained by applying water @ 100% of ET_c + 100% RDF + mulch with once in 2 days irrigation frequency followed by 80% of ET_c + 100% RDF + mulch with crop yield (36.5 t/ha). Minimum yield (25.6 t ha^{-1}) was obtained at 100% of ET_c + 80% RDF + open condition at once in 2 days irrigation frequency (Fig. 6.7.1.). Hence, water and nutrient becomes limiting factor, once in two days irrigation would be most appropriate irrigation level for growing cabbage under mulch cum drip irrigation system in hilly region.

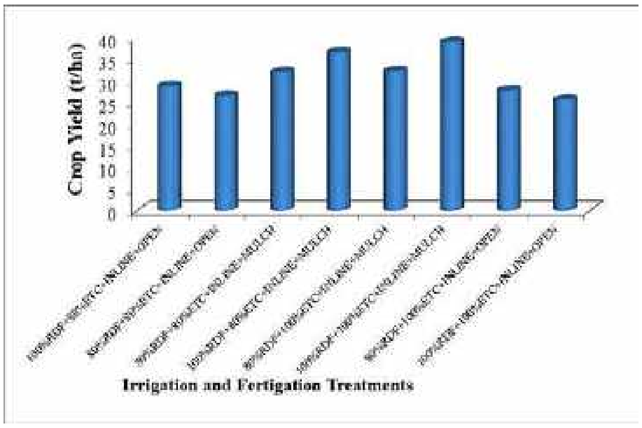
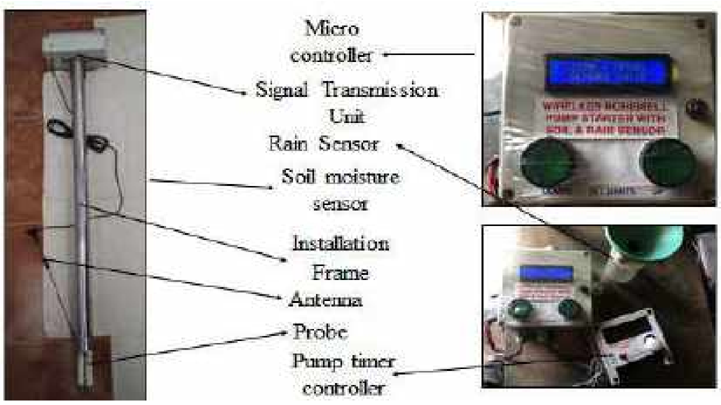


Fig. 6.7.1. Cabbage crop yield under different irrigation and fertigation treatment

Development of sensor network based irrigation system for improving agricultural water productivity

A soil moisture sensor was developed which, switched on irrigation pump/solenoid valve when soil moisture level depletes to pre-defined lower limit and switch off when soil moisture reaches field capacity or any other pre-determined upper limit of soil moisture content. Soil moisture sensor measures the water content in soil. Rain sensor was also integrated with controller for monitoring rainfall on real time basis. Here, the integrated system help to sense the moisture in field and transfer it to micro-controller in order to take controlling action of switching water pump and solenoid valve ON/OFF on real time basis. Controlling duration of the irrigation system is done by using timer-controller and receiver. This receiver consists of a GSM and a timer that was programmed as per the duration of irrigation. The receiver receives command in the form of sensor code no. from the user's mobile phone for switch on/off the solenoid valve and pump of particular plot. The performance evaluation of developed sensor was calibrated with gravimetric methods and compared with time domain reflectometry with satisfactory results. The design is still in a prototype stage. The automated irrigation system developed in the present research



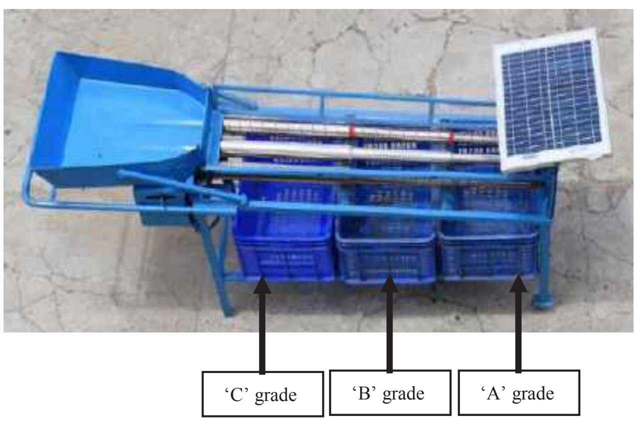
Components of sensor based irrigation system

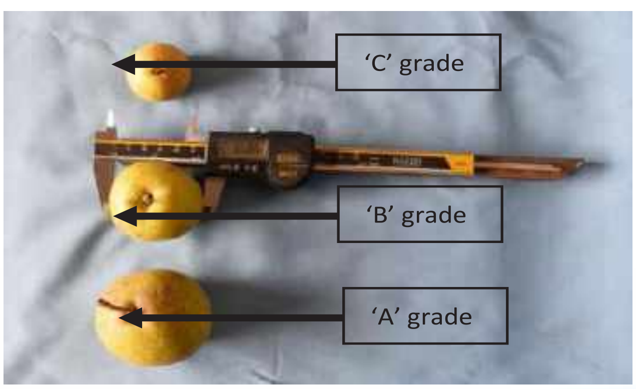
Instatallation and calibration of developed sensor in experimental field

work would ensure economic use of most precious input in agriculture *i.e.* water. Farmers may be able to control the time and amount of water to be applied for achieving desired target crop yield using sensor based irrigation system.

6.7.2. Post Harvest Technology for Value Addition and Marketing of Agricultural Produce (AICRP on PHET)

ICAR-VPKAS developed a light weight (40 kg) multi fruit cum-vegetable grader suitable for hilly areas, which is solar (12 V DC motor) as well as manual (hand) operated. It grades fruits and vegetables in to three grading (A, B & C). Gaps for grading of different fruits and vegetables can be adjusted manually. The dimensions of the grader are 200x60x120 cm with hopper capacity of 10 kg. The grading capacity is 400 to 600 kg fruits or vegetables/hour depending on type of commodity to be graded. It has stainless steel rollers which can grade into three graders with rpm of 70 to 100 depending on load. The multi fruit-cum-vegetable grader reduce the labour requirement of manual grading and also enhance uniformity of grading which increases marketing efficiency.





Fruit grading machine

6.7.3. All India Network Project on Soil Arthropod Pests (White Grub)

***In-situ* distribution of white grub beetles in experimental farm, Hawalbag**

A total of 45 species of white grub beetles are targeted for estimating the species abundance in *in-situ* conditions at experimental farm, Hawalbag. Individual beetles were collected during May to July, 2020 from 19.00 to 21.00 hours of the day from different host plants, *viz. Rosa indica, Helianthus annuus, Zinnia elegans, Sapium* sp, *Largestroemia indica, Carya illinoinesis, Ligustrum nepalensis, Hibiscus rosa-sinensis* and *Juglans regia*. On each day beetles are sorted according to species and counts are estimated for the relative abundance of the species. During 2020, amongst the *in-situ* beetles collected (a total of 8496 beetles), predominate ones are *Sophrophs* sp. and *Holotrichia seticollis* with 23.6 and 22.1% of total collection (Fig. 6.7.2). Other predominant species are *Anomala bengalensis* and *Adoretus versutus* with an abundance of 15.7 and 15.3% of total collection, respectively. Amongst the collection, species belonging to sub-family Melolonthinae are the predominate (Fig. 6.7.3) in all the three months of collection followed by Rutellinae. The diversity in Melolonthinae is manifested by 7, 18 and 14 species in May, June and July months, respectively. Whereas,

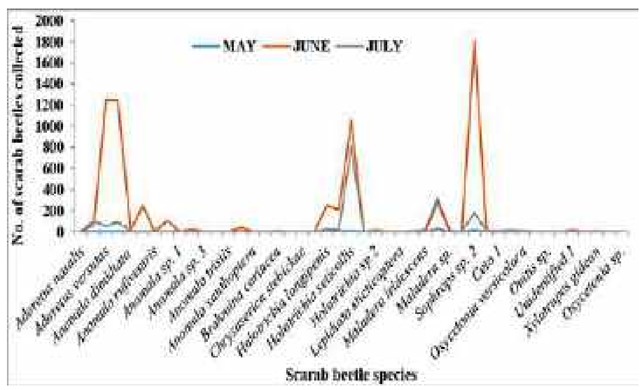


Fig. 6.7.2. ***In situ*** **distribution of white grub species in experimental farm, Hawalbagh**

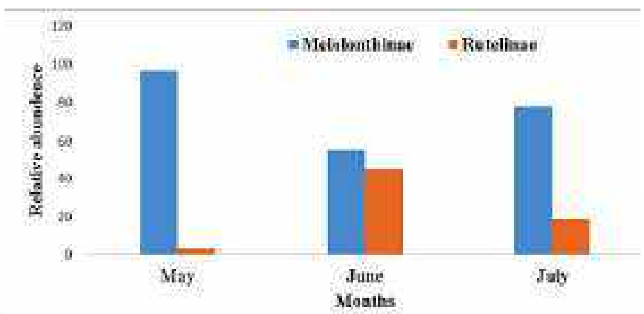


Fig. 6.7.3. Subfamily wise abundance of white grubs over the months during ***kharif*** **2020**

the diversity in Rutellinae is manifested by 3, 15 and 6 species in May, June and July months, respectively.

Whitegrub species distribution at different altitudes/ locations in Uttarakhand Himalayas

The existing micro-climate of Uttarakhand Himalayas lead to predominance of particular species of whitegrubs in different locations and altitudes. To study this species divergence, a preliminary study was conducted by installing light traps at seven strategic locations covering low, mid and high hill regions. The trap catches during July, 2020 revealed that both species diversity and richness is unique to the locations tested (Table 6.7.1.). Amongst the locations tested, *Xylotrupus* sp. and *Phaeochrus* sp. are predominating in Uttarakhand hills.

Efficacy of insecticides against common Pleurostict scarab beetle species

The efficacy of 20 commonly used insecticides (both conventional and novel group of insecticides) was evaluated against adult beetles of phytophagous scarab species (*Adoretus simplex, Adoretus versutus, Anomala bengalensis, Anomala dimidiata, Holotrichia longipennis, Holotrichia rosettae, Holotrichia seticollis, Maladera similana* and *Sophrops* sp.). All the insecticides were evaluated for their ingestion toxicity. Scarab beetle species differed significantly in their response to some of the tested insecticides. *Maladera similana* was found to be the most susceptible species to all insecticides tested. Among the twenty insecticides, chlorpyriphos 20% EC @ 2 ml/l, dichlorvos 76% EC @ 1 ml/l, lambdacyhalothrin 5% EC @ 1 ml/l and acephate 75% SP @ 1.6 g/l recorded high mortality, whereas buprofezin 25% SC@ 2 ml/l recorded low mortality of all 9 scarab species in leaf dip bioassay.

6.7.4 AICRP on Mushroom

A total of 07 high yielding varieties/strains of oyster mushroom (*Pleurotus* spp) were evaluated on wheat straw for their yield. Out of strains tested, strain PL 19-06 resulted in significantly higher yield (997.3kg/ 100 kg dry straw) followed by strain PL 19-03 (894.7kg/ kg dry straw). Under Advance Varietal Trial-I, seven strains of Lions Maine Mushroom (*Hericium erinaceus)* were evaluated on wheat straw for yield and strain He 19-08 yielded 88.89 kg/100 kg dry wheat straw substrate.

6.7.5. Network Project on Organic Farming (NPOF)

Evaluation of organic, inorganic and integrated production systems

Different crop management practices were evaluated for finger millet + black soybean (2:1 ratio – substitution of row)-wheat + *toria* (2:1 ratio) and grain amaranth-wheat + lentil (2:1 ratio) under rainfed system. Application of 100% of the recommended N of crop through farmyard manure (FYM) produced highest energy equivalent grain yield of 52.0 × 10^3

Table.6.7.1. Distribution of top five species and their abundance at different altitudes of Uttarakhand Himalayas

Details	Low hills	Mid hills			High hills		
Location	Chinyalisaur 30.5840°N, 78.3150°E	Jeolikote 29.3428°N, 79.4837°E	Kafligair 29.4507°N, 79.4432°E	Hawalbagh 29.6428°N, 79.6327°E	Chaukhutiya 29.8839°N, 79.3489°E	Gwaldum 30.0061°N, 79.5688°E	Mukteshwar 29.4604°N, 79.6558°E
Elevation (m amsl)	909	1219	1245	1250	1646	1940	2171
Species/ relative abundance (number)	*Alisonotum simile*/ 30.4	*Phaeochrus* sp./ 80.3	*Xylotrupes Gideon*/ 51.1	*Anomala dimidiat*/ 20.92	*Phaeochrus* sp./ 67.1	*Xylotrupes gideon* / 30.04	*Hilyotrogus holosericeu*/ 56.4
	Anomala sp./ 28.1	*Holotrichia longipenis*/ 6.98	*Maladera similana*/ 8.89	*Maladera similana*/ 17.16	*Xylotrupes Gideon*/ 11.2	*Maladera similana*/ 14.65	*Xylotrupes Gideon*/ 12.1
	Heteronychus lioderes / 10.5	*Xylotrupes gideon* / 3.17	*Holotrichia seticollis* / 6.67	*Xylotrupes gideon* / 9.09	*Anticephala batillina* / 4.9	*Anomala rufiventri*/ 11.81	*Melolontha nepelensis* / 7.86
Species richness (number)	17	16	13	51	17	31	19

and 58.2 × 10^3 MJ/ha for both finger millet + black soybean-wheat + *toria* and grain amaranth-wheat + lentil, respectively (Fig. 6.7.4.). Application of 100% of the recommended N of crop through FYM recorded 126 and 112% higher energy equivalent grain yield of finger millet + black soybean-wheat + *toria* and grain amaranth-wheat + lentil, respectively than 100% inorganic package, respectively.

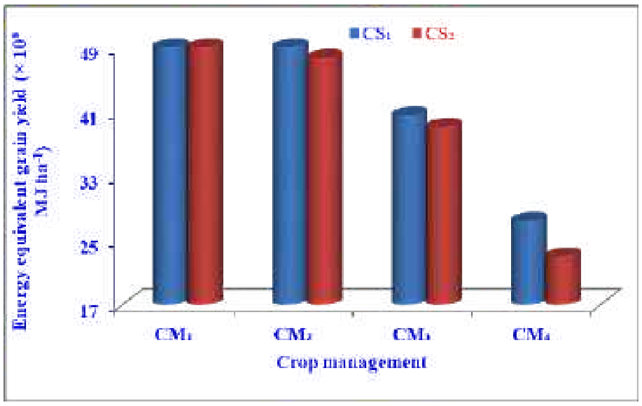


Fig. 6.7.4. Energy equivalent grain yield of finger millet + black soybean-wheat + *toria* and grain amaranth-wheat + lentil in different crop mnagement system (CM_1 = 100% organic (N equivalent); CM_2 = 75% organic + innovative practices (Innovative practices – 3% *Panchagavya* and vermi wash); CM_3 = 50% organic + 50% inorganic package; CM_4 = 100% inorganic package (NPK); CS_1= Grain Amaranth - Wheat + Lentil (2:1) CS_2 = Finger millet + Black Soybean (2:1) - Wheat + *Toria* (2:1))

Field evaluation of organic pest management options for pests of soybean

A field experiment with 7 treatments including control was laid out to evaluate the organic pest management options for soybean pests. The infestation of soybean crop by sucking bug, *Chauliops choprai* and aphids in the season was low to moderate (Table 6.7.2.). The application of 10% extract of *Melia azedarach* and nimbicidine 3 ml/l resulted in at par reduction of the sucking bug population up to 74%. However, against aphids, parthenium leaf extract 5% and 10% extract of *Melia azedarach* resulted in reduction of 46.9 and 46.5%, respectively.

Evaluation of organic pest management modules against sucking bug (Chauliops choprai)

Among the pest management modules tested, the insecticide cartap hydrochloride @ 1g/l provided

Table 6.7.2. Effect of organics on the management of sucking bug and aphid of soybean

Treatment	Per cent reduction			
	w.r.t. PTC		w.r.t. control	
	C. choprai	Aphids	*C. choprai*	Aphids
Melia azedarach extract 5%	62.16	36.34	4.14	17.08
Melia azedarach extract 10%	73.81	46.52	27.92	39.37
Nimbicidine 3 ml/l	73.81	36.39	27.92	39.25
Beauveria bassiana 3g/l	56.00	45.64	21.10	19.01
Parthenium extract 5%	67.50	46.89	10.55	16.26
Cartap hydrochloride 1g/l	79.07	87.85	42.39	73.41
Control	-65.625	-22.43		

PTC – Pre Treatment Count, * (Mean of six replications)

Table 6.7.3. Effect of organics on the management of sucking bug of soybean in the laboratory

Treatment	Per cent mortality			Average
	24 HAT	48 HAT	72 HAT	
Melia azedarach (Batain) extract 5%	0	3.3	6.7	3.33
Melia azedarach (Batain) extract 10%	0	10.0	23.3	11.10
Nimbicidine 3 mL/l	0	16.7	23.3	13.33
Beauveria bassiana 3 g/l	6.7	6.7	6.7	6.70
Parthenium extract 5%	3.0	6.7	26.7	12.13
Metarhizium anisopliae 3 g/l	6.7	13.3	13.3	11.10
Cartap hydrochloride 1 g/l	100.0	-	-	100.00
Control	0	0	0	0.00

HAT – hours after treatment

100% mortality of the test insect within 24 hours after treatment. Among the organic pest management modules, extracts of *Parthenium*, *Melia azedarach* and commercial Nimbicidine caused up to 25% mortality after 72 hours after treatment (Table 6.7.3.).

Pest incidence in organic production system

The infestation/damage of leaf webber in grain amaranth grown in full organic conditions was 6.8%, whereas it was 11.0% damage in full inorganic plots (Table 6.7.4). Soybean grown under full organic condition was found to harbour more number of sucking bug, *Chauliops choprai* (13.8 bugs per 3 leaves) and 100% inorganic had the least number of sucking bugs (8.2 bugs per 3 leaves). The infestations of aphids in *toria* under wheat + *toria* intercropping were 48, 44 and 56 and 60% for application of 100% N requirement of crop through FYM, 75% N requirement of crop through FYM + 3% *Panchagavya* + Vermiwash, INM and 100% inorganic conditions, respectively. No insect pest incidence was observed in wheat crop.

Table 6.7.4. Infestation of insect under different production systems

Treatment	Amaranth leaf webber damage %)	Soybean sucking bug (No/ 3 leaves)	Toria Aphid infestation (%)
100% Organic	6.8	13.8	48
75% Organic + 3% *Panchagavya* + Vermiwash	7.6	11.0	44
50% Organic + 50% inorganic (INM)	10.4	8.4	56
100% Inorganic	11.0	8.2	60

Effect of organics in the management of aphids in toria

An experiment was conducted in the laboratory to evaluate the organic pest management options for the management of aphids in *toria*. The twigs infested with toria aphids were brought to laboratory and used for bioassay. A total of six different organic options were tested against *toria* aphids in the laboratory which contains three botanical extracts of batain, artemisia and pine; two bioagents, a commercially available neem oil formulation (Nimbicidine) and a chemical pesticide, acetamiprid. The insecticide, acetamiprid was found to reduce the infestation of aphids in *toria* considerably with more than 93.5% mortality in aphid population. The second best treatment was the commercial neem oil (Nimbicidine) which was found to cause 39.3% mortality in aphiod population at 3 ml/l. The commercial fungal biocontrol agents, *Metarrhizium anisopliae* and *Beauveria bassiana* did not report any mortality of the aphid.

Organic management of toria aphids

A field experiment was conducted to evaluate the organic pest management options for the management of aphids in *toria*. Pre-treatment count showed severe infestation of aphids which accounts to 100% plants infested with aphids. None of the bioagents or botanicals was found effective against *toria* aphid. Only insecticide, acetamiprid was found to reduce the infestation of aphids in *toria* up to 87%. Among organic management, nimbicidine reduced 22% of aphid infestation.

Disease infestation in organic and inorganic production system

In general, the disease severity was high in the *rabi* crops. But, the intensity of different diseases in

Table 6.7.5. Disease index in different crops under organic and inorganic production system during *rabi* 2019-20

Treatment		Wheat + *toria* intercropping			
	Wheat			Toria	
	Yellow* rust	Brown rust	Powdery mildew	*Alternaria* leaf spot (%)	
100% Organic	20S	10S	3	2	
75% Organic + 3% *Panchagavya* + Vermi wash	40S	10S	5	5	
50% Organic + 50% inorganic	10S	5S	1	10	
100% Inorganic	40S	0	1	10	
		Wheat + lentil intercropping			
		Wheat		Lentil	
	Yellow rust	Brown rust	Powdery mildew	Wilt (%)	Root rot (%)

100% Organic	60S	0	3	2	0
75% Organic + 3% *Panchagavya* + Vermi wash	60S	5S	1	5	1
50% Organic + 50% inorganic	60S	TS	3	8	2
100% Inorganic	60S	0	5	10	2

* Scale for yellow rust and brown rust of wheat = 0-100S scale
Scale for powdery mildew of wheat = 0-9 scale
Scale for Alternaria leaf spot of *toria*; and wilt and root rot of lentil = 0-100%

Table 6.7.6. Disease index in different crops under organic and inorganic production system during *kharif* 2020

Treatment	Finger millet + black soybean intercropping			
	Finger millet		Black soybean	
	Fingerblast*	Leaf spot	Frog eye leaf spot	Bacterial pustule
100% Organic	1	5	1	2
75% Organic + 3% *Panchagavya* + Vermi wash	1	5	3	3
50% Organic + 50% inorganic	3	7	3	3
100% Inorganic	3	7	5	5
	Anthracnose in grain amaranth			
100% Organic	7			
75% Organic + 3% *Panchagavya* + Vermi wash	7			
50% Organic + 50% inorganic	5			
100% Inorganic	3			

*Scale for finger blast and leaf spot of finger millet; Frog eye leaf spot, bacterial pustule of black soybean; Anthracnose of grain amaranth = 0-9 scale

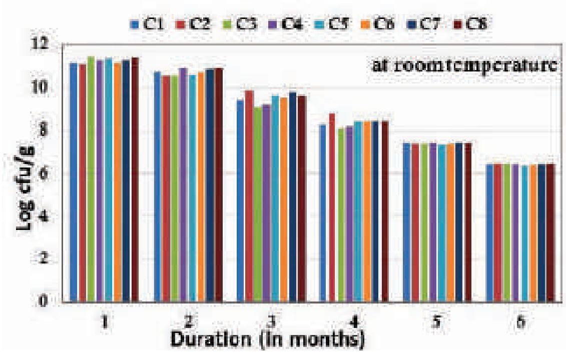
different crops during *kharif* and *rabi* season was relatively higher under inorganic management system compared to other systems (Table 6.7.5. and 6.7.6.). The management with organic inputs recorded very low infestation of various pathogens.

The intensity of different diseases in different crops during *kharif* season was relatively higher under inorganic management system compared to other systems (Table 6.7.6.). The management with organic inputs recorded very low infestation of various pathogens.

6.8. Application of Microorganisms in Agriculture and Allied Sectors (AMAAS) Project

Developing PGPR consortia for enhanced micronutrient (iron and zinc) uptake and yield of finger millet (Eleusine coracana) in hilly areas

Shelf-life of eight charcoal based bacterial consortium were evaluated upto six months at room temperature (25ºC) and freezer (4ºC). Initial log cfu/g in standard charcoal-based formulation was in the range of 11.08 to 11.45. After six months standard carrier materials (charcoal + soil) showed log cfu in the range of (7.32 to 7.79) & (6.35 to 6.45) under refrigerated and non- refrigerated conditions, respectively (Fig. 6.8.1.).



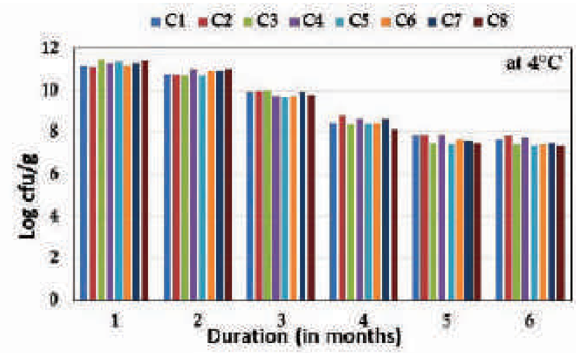


Fig. 6.8.1. Shelf-life of eight bacterial consortia at ambient and 4ºC temperature

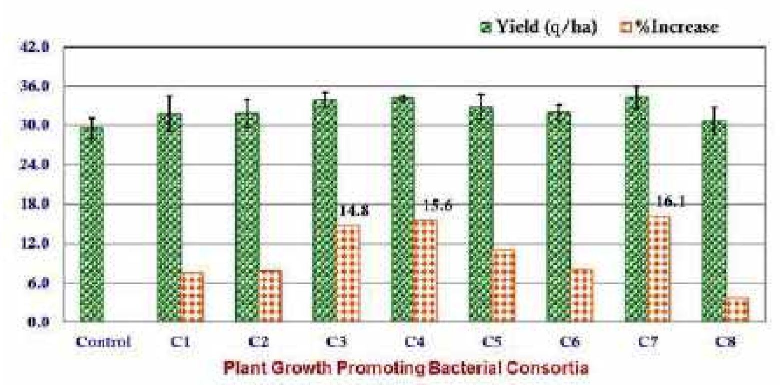


Fig. 6.8.2. Evaluation of PGP bacterial consortium on Zn and Fe uptake of finger millet (VL *Mandua* 379)

Eight PGPR bacterial consortia along with uninoculated control were evaluated for plant growth promotion and micronutrient (Zn and Fe) uptake in finger millet varieties (VL *Mandua* 379) under field conditions during *kharif* 2020 at organic block, Kosi Sector of Experimental farm, Hawalbagh. Seed inoculation of finger millet with PGP bacterial consortia had significantly (P>0.05) improved root length (1.0–1.27 fold), shoot length (1.0–1.40 fold), dry root biomass (1.19–1.67 fold), dry shoot biomass (1.0–1.9 fold increase), proline content (2.5-31.6%), total phenolics (5.4 to 28.6%) and physiologically available iron (1.35–3.29 fold) in all the treatments as compared to uninoculated control at 90DAS. Bacterization with PGPR bacterial consortia significantly decreased electrolyte leakage and increase relative water content in wheat plants as compared to uninoculated control. Consortium C6 enhanced rhizospheric protease and urease (enzyme activity by 18.5 and 25.8%, respectively over control (216.73 µ tyr.g^{-1} dm.$2hr^{-1}$ and 241.15 µg N.g^{-1} dm.$2h^{-1}$, respectively) at 90DAS. Inoculation of finger millet seed with consortium C7, C4 and C3 enhanced finger millet yield 16.1, 15.6 & 14.8% as compared to uninoculated control (22.5 q/ha) under field conditions (Fig. 6.8.2.).

6.9. NICRA Project under Competitive Grants Component (CGS)

Design & development of protective structures for high values crops to reduce damage from hail and frost

A field day-cum-demonstration programme was organized in the village Pithholi (Nainital) on December 16, 2020. Farmers were made aware about the crop losses due to frost and hails and measures to be taken to protect the crop from these calamities. Demonstration were laid on use of VL Polytunnel for raising nurseries and inputs like VL polytunnels (32), VL Hand Fork (55), VL *Kutla* (55), 55 seed packets each of tomato, cauliflower and cabbage seed and 7,000 seedllings of onion were distributed to the Schedule Caste (SC) farmers. One hundred twenty VL polytunnels have been distributed to farmer's through different projects/ programmes of the Institute.

VL Polytunnel demonstration and input distribution at farmer's field

The VL polytunnel was tested for different crops and nurseries during October to December 2020 in the High Altitute Testing Site, Mukteshwar (2250 m amsl). The soil temperature (5 cm depth) inside the VL Polytunnel during morning (07:12 AM) and evening (14:12 PM) was 2.5 and 4.8 °C higher than outside while in 10 cm depth it was higher by 3.3 and 2.9 °C, respectively. This higher soil temperature inside the VL polytunnel resulted in early germination and better crop growth than outside open conditions (Fig. 6.9.1.).

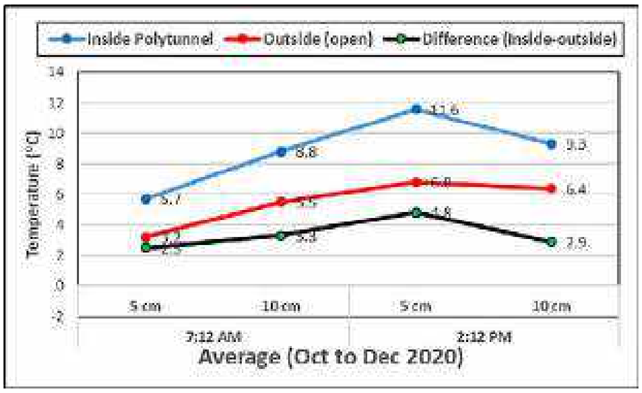


Fig.6.9.1. Soil temperature variation inside and outside the VL Polytunnel

Growth performance of radish inside VL Polytunnel (LHS) and outside (RHS) in high hills in Mukteshwar

6.10. National Mission on Himalayan Studies (NMHS)

6.10.1. Strategies to Improve Health and Nutritional Status of Hill Farm Women through Technological Intervention

Nutrition sensitive agricultural interventions were promoted to enhance health and nutritional status of women in high hills of Uttarakhand. Nutrition sensitive approach was promoted at local level with active participation of women, mainly responsible for food security of the households. The nutrition-sensitive agriculture interventions were implemented in three main areas:

Food diversity was enhanced through production of diverse crops

Diverse crops were promoted through family farming, nutri-gardens and homestead food production of vegetables, fruits, mushroom, honey, micro-greens etc at local levels.

Enhanced availability of micro-nutrient rich vegetable through nutri-gardens at local level

Bee-keeping introduced for food security and income generation

Inclusion of mushroom and micro-greens in diet

Food productivity was enhanced for making enough food available and accessible at local level

High yielding varieties of wheat, finger millet and lentil (major crops of hill region) were introduced along with the recommended package of practices.

Enhanced productivity through improved crop varieties

Making food itself more nutritious

Production and incorporation of fortified crop varieties in diet can improve nutritional status. Local cultivars of maize used by women were replaced by Vivek QPM 9.

Changes in nutrient intake after intervention

An attempt was made to assess the change in diet and nutrition profiling of women as a result of nutrition sensitive agriculture interventions. Information regarding food intake was obtained from farm women using 24 hours recall method using pre-structured interview schedule. The data pertaining to the daily intake of food stuff along with quantity was collected using 24 hours recall method (2 recalls).

The average daily intake of foods by individual respondents was computed and compared with the ICMR 2020 suggested levels of intake. The nutritive value for the quantity of raw foods consumed by the individual respondents were calculated by using food composition tables and compared with the Recommended Daily Allowances (RDA). This data was taken before and after nutrition sensitive agriculture interventions in the project area.

Data showed that average consumption of various nutrients, *viz*. protein 57.6 (±8.2) g, calcium 788 (±175) mg, iron 22.8 (±3.1) mg, zinc 11.4 (±1.5) mg, vitamin A 606 (±312) μg, energy 1681 (±217.5) kcal, thiamine 1.5 (±0.2) mg, riboflavin 0.9 (±0.2) mg and niacin 10.9 (±1.4) mg was enhanced as a result of intervention (Table 6.10.1.). However, the average consumption of calcium, iron, zinc, vitamin A, energy, thiamin, riboflavin and niacin is still less than RDA.

It was also found that average consumption of pulses by women respondents before and after intervention was 26 (±21) g and 45 (±16.5) g which was less than Recommended Dietary Intake (RDI) of 60 g by a moderate women worker (Table 6.10.2.). Similarly, consumption of milk and milk products and fruits was less than RDI. Data analysis showed that average vegetable consumption before intervention was 291.4 ± 55.9 g whereas after intervention average consumption was 384 ± 72 g

Table 6.10.1. Average consumption of various nutrients in comparison to RDA (Female moderate worker)

Nutrients	RDA 2020	Average consumption Mean±SD (Before Intervention)	Average consumption Mean±SD (After Intervention)
Protein (gm)	46	48.4 (±7.0)	57.6 (±8.2)
Calcium (mg)	1000	610 (±174.0)	788 (±175.1)
Iron (mg)	29	19.3 (±2.8)	22.8 (±3.1)
Zinc (mg)	13	10.5 (±1.3)	11.4 (±1.5)
Vitamin A (μg)	840	587 (±422)	606 (±312)
Energy (kcal)	2230	1530 (±190.7)	1681 (±217.5)
Thiamin (mg)	1.7	1.4 (±0.2)	1.5 (±0.2)
Riboflavin	2.4	0.7 (±0.1)	0.9 (±0.2)
Niacin	14	10.2 (±1.3)	10.9 (±1.4)

Table 6.10.2. Average consumption of various food items (g/day) in comparison to RDI

Food Items	RDI	Average consumption Mean± SD (Before Intervention)	Average consumption Mean± SD (After Intervention)
Cereals and Millets (g)	350	365 (± 45)	371 (±56.5)
Pulses (g)	60	26 (±21)	45 (±16.5)
Green leafy vegetables (g)	125	80.8 (± 51)	97 (±51.7)
Other vegetables (g)	75	20.7 (±24)	88.8 (±34.4)
Roots and tubers (g)	75	189 (±45)	198 (±37.8)
Milk and milk products (g)	200	106 (± 45)	150 (±52.8)
Meat/Fish/Egg/Mushrooms		0	15.5 (±20.9)
Fruits (g)	100	20 (± 25.3)	36 (±43.9)

per day. The health benefits of fruit and vegetable seen in epidemiological studies are the main reasons for the recommended intake of at least 400 g of fruit and vegetable per day, potatoes not included. It was also found that portion of green vegetable and other vegetable was 34.9% before intervention which was increased to 48.4% after intervention. Therefore, roots and tuber are still the major vegetable food group consumed by women in high hills.

Nutrition focused women collectives

Under the project, women were organized in nutrition focused Self Help Groups, namely. Himalayan Self Help Group, Jogat in Uttarkashi district. This group was formed to enhance feasibility and effectiveness of nutrition focused interventions.

Nutrition focused women collectives

6.10.2. Characterization of Kidney Bean (*Rajmah*) Rhizosphere Microbiome from Higher Altitude of Indian Central Himalaya

Soil sample collection: A total of thirteen soil sub-samples were taken randomly from a 10-cm depth and placed into sterile whirl bags from village Kailashpur of Chamoli district before bioinoculant application at an altitude (3014 to 3130 m amsl) along with GPS coordinates. The sub-soil samples from fields were composited (approximately 1kg). Samples were pooled and categorized as Lower Kailashpur (LK) and Upper Kailashpur (UK). Samples were returned to the lab under refrigeration and passed through a 2-mm sterile sieve and stored at 4ºC.

Chemical and biological analysis: The soil analysis revealed considerable differences in a number of soil characteristics and range. There was no significant difference observed at Lower Kailashpur (LK) and Upper Kailashpur (UK) in all the soil, microbial and enzymatic characteristics examined. Among both (LK and UK), pH, EC and organic carbon ranged (6.5–6.8), (0.043–0.057) and (0.55–0.74), respectively. While macronutrient N, P, K ranged (401.3–512.0), (17.5–22.6) & (200.5–236.3kg/ha), respectively (Table 6.10.3 and 6.10.4). In addition to these, both sites represent high iron (38.1–50.9ppm) and manganese (36.1–43.5ppm) content (Fig. 6.10.3). However, among the soil enzymes, both LK and UK showed highest (639.57 and 687.52 μgpNP.gm^{-1}dm.h^{-1}, respectively) amount of alkaline phosphomonoesterase enzyme activity, involved in 'P' mineralization (Fig. 6.10.2). These soil enzymes will be useful for soil quality biological indicators or biological fingerprints of soil management and relate to soil tillage and structure.

Microbial estimations: Properly diluted (10^3–10^7) soil aliquots were inoculated onto total counts agar (TCA), rock phosphate, Kings B agar and Jensen's media were used for the enumeration of total bacteria, phosphate solubilizers, pseudomonad and diazotrophs. The highest soil sample dilution (10^6 and 10^7) facilitated the detection of slow-growth microorganisms by reducing the effect of overgrowth by fast-growing microorganisms. The plates were incubated at 28ºC up to 07 days to detect slow-growth microorganisms. Bacterial counts were made 24-48h after plating. Each soil sample was analysed in triplicate and the dilution series plated. Counts were transformed in log cfu/g dry weight soil. There was no significant difference among the LK and UK microbial counts (Fig. 6.10.3). Two-way analysis revealed that there is no significant difference in microbial biomass contents at LK and UK (Fig. 6.10.4).

Table 6.10.3. Soil characteristics of Kailashpur samples before bioinoculant application

Locations	pH	EC (dS/m)	Organic Carbon (%)	Available macro-nutrients (kg/ha)			Available micro-nutrients (ppm)			
				Nitrogen (N)	Phosphorous (P)	Potassium (K)	Zinc (Zn)	Iron (Fe)	Cupper (Cu)	Manganese (Mn)
Lower Kailashpur (LK)	6.5 – 6.8	0.043 – 0.057	0.62 – 0.74	405.5 – 503.7	17.5 – 20.6	202.7 – 236.3	0.958 – 1.145	38.1 – 49.6	1.56 – 2.54	36.1 – 43.5
Upper Kailashpur (UK)	6.5 – 6.7	0.043 – 0.057	0.55 – 0.74	401.3 – 512.0	19.8 – 22.6	200.5 – 219.5	0.917 – 1.226	39.2 – 50.9	1.23 – 2.31	37.9 – 41.7

Table 6.10.4. Soil enzymes activity of Kailashpur samples before bioinoculant application

Locations	Acid phosphomonoesterase (μgpNP.gm^{-1}dm.h^{-1})	Alkali phosphomonoesterase (μgpNP.gm^{-1}dm.h^{-1})	Total phosphomonoesterase (μgpNP. gm^{-1}dm.h^{-1})	Fluorescein diacetate (μg fluorescein gm^{-1}dm.h^{-1})	Urease activity (μgN.gm^{-1}dm.2h^{-1})	Protease activity (μgTyr. gm^{-1}dm.3h)
Lower Kailashpur (LK)	10.44 - 289.67	579.16 - 736.02	589.6 - 904.20	22.89 - 47.51	79.81 - 392.52	26.26 - 162.31
Upper Kailashpur (UK)	14.40 -204.64	541.14 - 856.37	626.77 - 870.78	22.23 - 49.10	213.74 - 373.70	32.56 - 211.16

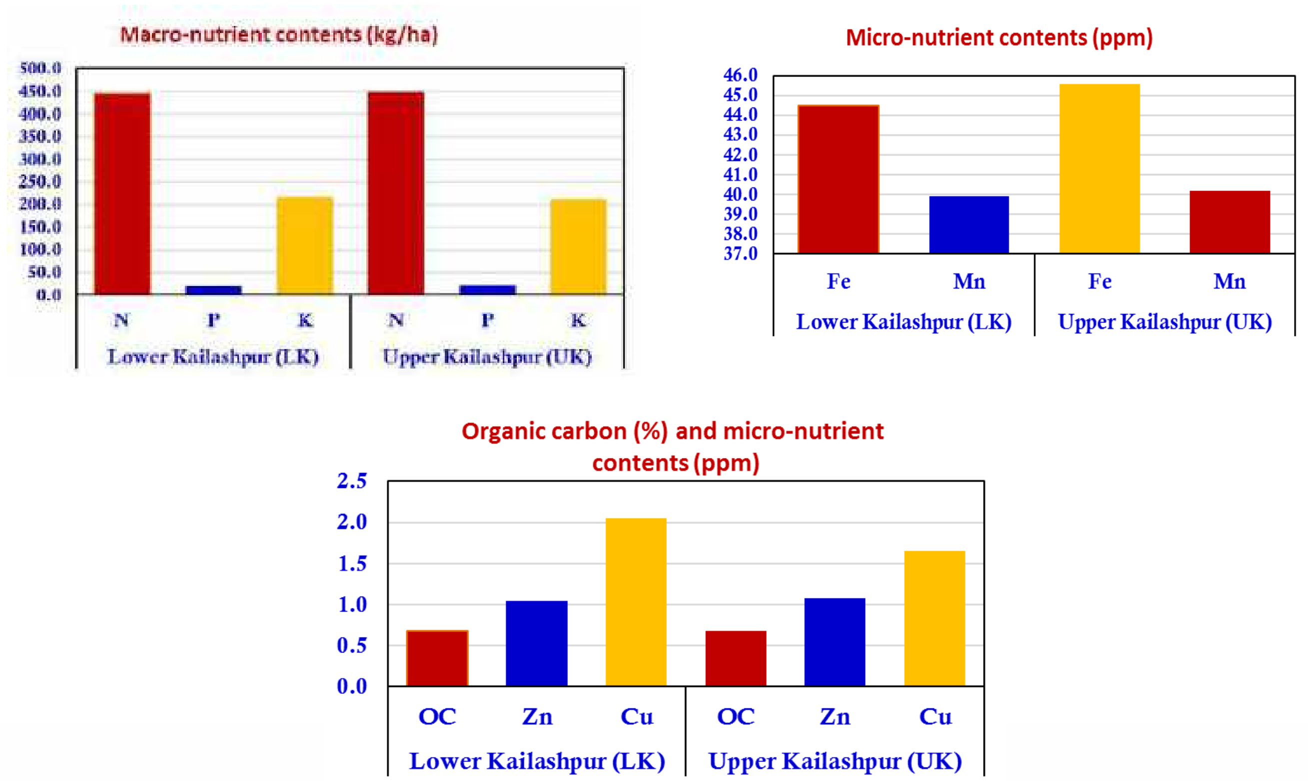


Fig. 6.10.1. Macro and micro-nutrient contents at lower and upper Kailashpur site

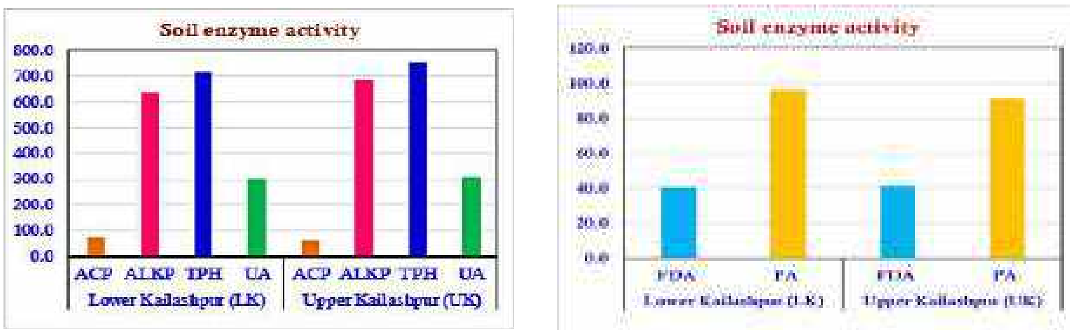


Fig. 6.10.2. Soil enzymes activity at Kailashpur site

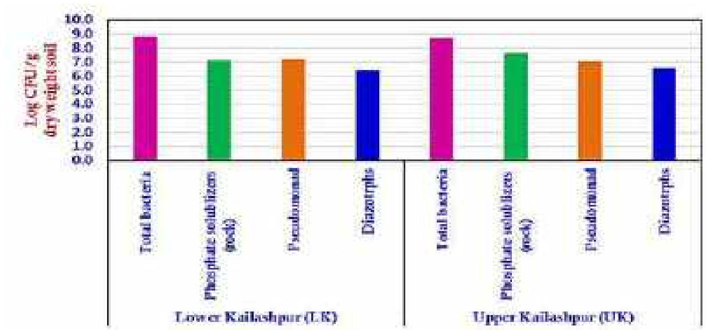


Fig. 6.10.3. Culturable bacterial counts (cfu/g dry weight soil) at Kailashpur site

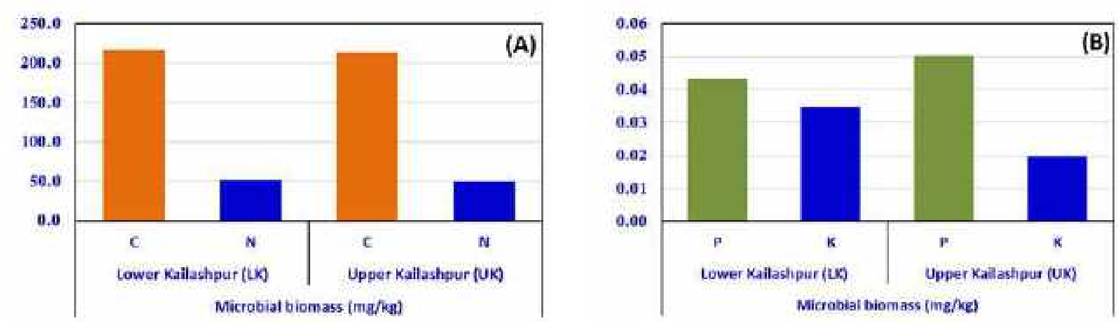


Fig. 6.10.4. Soil microbial biomass (A) carbon and nitrogen (B) phosphorous and potassium

6.11. National Mission for Sustaining the Himalayan Ecosystems (NMSHE) Taskforce 6 (Agriculture) for Lower and Middle Himalaya

Demonstration of crop and varieties

The *kharif* and *rabi* crop varieties demonstrated on farmers field were evaluated for yield (Table 6.11.1 & 6.11.2). It is revealed that most of the crops yield was lower at farmer's field than experimental yield but was higher than state average yield. It is worthwhile to mention that pulse crops yield was recorded very high and it was higher than experimental yield of conducted at research farm of ICAR-VPKAS, Almora. The millet yield was also recorded numerically higher than experimental yield.

Table 6.11.1. Grain yield of different *kharif* crop varieties **(Mean of four years)**

Crop	Variety	Yield (q/ha)			Exp. Yield (q/ha)	Deviation from Exp. Yield (%)
		Mean	Lowest	Highest		
Rice	Vivek *Dhan* 62	19.4	16.0	22.0	47.5 (45-50)	-59.2
	Vivek *Dhan* 86	15.8	12.0	21.0	47.5 (50-51)	-63.3
	Vivek *Dhan* 65	18.4	9.0	25.5	47.5 (45-50)	-61.4
	Vivek *Dhan* 85	18.35	10.0	22.0	42.5 (40-45)	-62.8

Barnyard millet	VL *Madira* 207	18.6	11	27	17.5 (16-19)	-24.4
	VL *Madira* 172	21.3	18	24	21.5 (20-23)	-9.4
Finger millet	VL *Madua* 352	16	9.5	25	27.5 (25-30)	-38.2
	VL *Madua* 324	16.7	8.5	22.5	20.5 (19-22)	-32.2
	VL *Madua* 149	14.5	11.0	18.2		-43.1
	VL *Madua* 315	17.6	9.5	25	22.5 (20-25)	-21.9
Soybean	VL *Soya* 65	28.6	22.5	35.0	12.5 (11-14)	-40.6
	VL *Soya* 47	29.5	22	35.0	26 (25-27)	-38.0
	VL *Soya* 63	28.8	23	35.0	27.58	-39.7
	VL *Bhat* 201	30.4	27.5	33.3		-39.9
Maize	VL *Makka* 31	15.4	10.5	27.5	42.5 (40-45)	-26.1
	VL Amber Popcorn	18.9	12.0	26.5	22.5 (20-25)	-7.6
	VL *Makka* 37	23.8	22.0	26.0	42.5 (40-45)	-2.9
	VL *Makka* 39	22.4	20.0	24.0	67.5 (65-70)	-12.2
	VL *Makka* 35	20.8	19.0	22.0	47.5 (45-50)	-21.5
Bean	VL Bean 2	13.7	9.0	22.5	110 (100-120)	-39.2
Amaranth (Chua)	VL *Chua* 44	9.25	3.5	14.0	11.5 (10-13)	-61.7
Horse gram	VL *Gahat* 19	21.5	15	27	5.64	-7.7
	VL *Gahat* 15	23.8	21.5	26	10.5 (9-12)	-1.3

Table 6.10.2. Performance of different varieties of crops in *rabi* season at *Jur Kafun*

Crop	Variety	Yield (q/ha) at farmer's field			Mean yield of variety at experimental farm	More /less yield as compared to experimental farm (%)
		Mean	Lowest	Highest		
Wheat	VL *Gehun* 829	21.6	17.5	25.5	25-30 (27.5) (rainfed) 40-45 (irrigated)	-21.5% Rainfed, -49.2% irrigated
	VL *Gehun* 892	19.8	16.3	25	30-35	-39.1% Rainfed,
	VL *Gehun* 907	21.3	18.1	26.5	25-28 (rainfed) 44-47 (irrigated)	-19.5% Rainfed -53.1% irrigated
	VL 804	17.5	15.5	19	25-30 (rainfed) 40-45 (irrigtaed)	-37.3% Rainfed -59.4% irrigated,
Lentil	VL *Masoor* 126	19.1	13.8	27	12—16	+36.4%
	VL *Masoor* 133	16.4	14.5	18	11.25	+45.6%
Barley	VL *Jau* 118	13.2	10.8	16	20-22	

Note: (-) means yield less than experimental farm, (+) means yield more than experimental farm

Demonstration of improved water storage tank at farmers field

Crop protection investigations

As per the survey on the incidence of pests in the adopted village, medium to high infestation (11-38%) of fruit flies in cucurbits and low to medium infestation of bean pod borer (6%) were noticed. Scarab beetles like, *Anomala lineatopennis, Holotrichia seticollis* and *H. longipennis* were found to get attracted and caught in the light trap during the month of June. *Anomala lineatopennis* was found to occupy 31% of total scarab beetle catches through VL whitegrub beetle traps in the village during June. Fruit flies are controlled by installing cue lure traps in cucurbits. Honey bee, *Apis cereana* boxes (5 colonies) are being maintained.

Capacity building and forecasting

Adaptations made by farmers towards adverse effects of climate change

It is evident from distribution of respondents on the basis of adaptation in farming practices before intervention (Fig. 6.11.1) that majority of the respondents (63%) did not make any adjustments in their farming practices to cope-up with climate change, and 37% of the respondents made (some sort of) adjustment in their farming practices. Farmers were aware of climate change and its effect on agriculture but were not aware of the technologies, which helps in combating the climate change. The information on climate smart activities was meagre as there was no regular source of information pertaining to farming practices for adaptation to climate change. The farmers were willing to adapt the technologies but lack of awareness and capital were the main constraints.

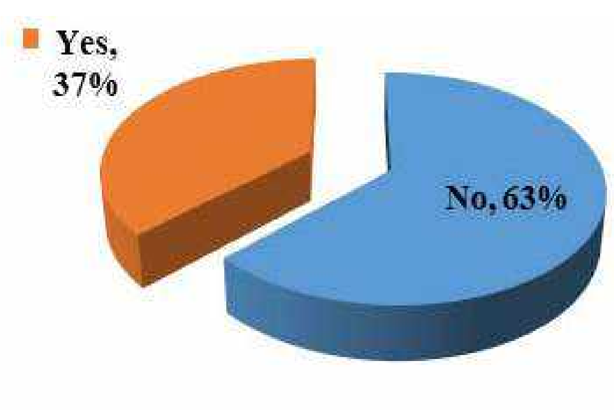


Fig. 6.11.1. Distribution of respondents on the basis of adaptation in farming practices before intervention

Adaptation practices used by farmers to cope-up with climate change

Adaptation practices used by farmers to cope-up with climate change are presented in fig. 6.11.2 revealed that majority of the respondents (80%) had changed the crop varieties due to less production but were not aware that those were drought tolerant varieties. A few farmers (15%) were of view that they tried drought tolerant varieties of *rabi* crops provided by State department of agriculture. Forty-three percent of respondents reduced their number of livestock as a coping strategy to lack of water and fodder and 25% had changed their cattle breeds. For *rabi* crops, farmers (50%) had changed date of sowing of wheat in order to avoid adverse impact of climate change due to less winter rains. The area under wheat is also reduced (43.8%). Other adjustments reported by farmers were- diversification of crop types and varieties (15%), implement soil conservation schemes like mulching (40%) especially for nursery raising, diversification of livestock types and varieties (25%) and diversify from farming to non-farming activity (45%). Most of the male members were working in hotel/ industries outside of Uttarakhand. However, only 10% of respondents built water harvesting structure to cope-up with climate changes which were found to be non-functional. Farmers had participated in aforestation programmes (60%) and water bodies' rejuvenation programmes (50%) also. None of the respondent used crop insurance to protect their crops from adverse impact of climatic conditions. Thus, changes in crop varieties reduce number of livestock, shifting to non-farm activities, changing planting dates and changing size of land under cultivation

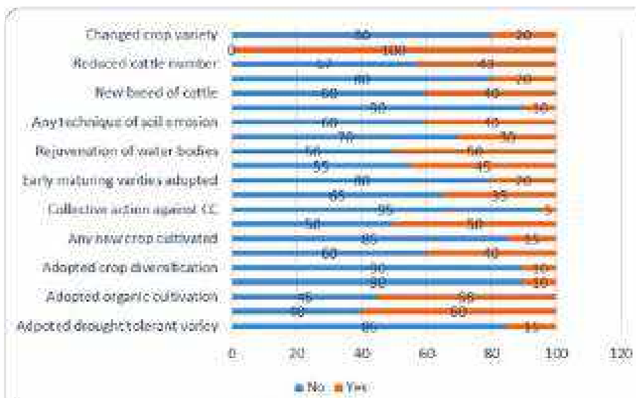


Fig. 6.11.2. Type of adaptation used by farmers before intervention

were the major adaptation practices followed by farmers in the study area. It was also found that they have used more than one type of adaptation strategies. This decision implies that a single strategy was found to be inadequate in adapting to the impact of climate variability and change, and combination of strategies is likely to be more effective than a single strategy. An exposure visit of farmers to Institute and demonstration cum training on *Vivek* Millet Thresher was organised in the institute during Hon'ble CM's visit on January 4, 2020.

High Altitude Testing Site (HATS), Mukteshwar

Yield evaluation trial

Garden pea: Thirty new genotypes of garden pea (advance lines) including seven checks were evaluated for their suitability to high altitude during off season in randomized block design during *Kharif,* 2019. VP 1802 and VP 1803 produced 118.2 q/ha and 102.2 q/ha green pod yield, respectively.

Field screening of advance lines and varieties of french bean for important diseases

A replicated trial on field screening of advance lines (17) and varieties (04) of french bean was undertaken during the season *kharif* 2020 at High Altitude Testing Station (HATS), Mukteshwar (2250 m amsl). The aim of this study was to conduct a field screening of better performing french bean advance lines (>95 q/ha green pod yield) with varieties against important fungal diseases prevalent under hills conditions *viz*., Angular Leaf Spot/ALS (*Phaeoisariopsis* sp.), Rust (*Uromyces* sp.) and Anthracnose (*Colletotrichum* sp.). The disease incidence data were collected during the crop green pod stage and converted into the disease percentage (%).

The advance line VLFB 1827 recorded lowest ALS (20%). The advance lines VLFB 1819, VLFB 1907 and varieties *Pant Anupama*, *Arka Suvidha* showed 0% rust incidence. Total four advance lines *viz*., VLFB 1803, VLFB 1805, VLFB 1806 and VLFB1908 were observed with 0% Anthracnose incidence during the green pod stage.

Breeder seed production

Onion & Garlic: Breeder seed crop of VL *Piaz* 3 and VL *Lahsun* 2 (long day garlic) have been grown in 200 m^2 and 400 m^2 area and 3q and 8q bulb, respectively as planting materials were produced and supplied to the Institute.

Seedling production

Around 3 lakhs seedling of VL *Piaz* 3 were produced and supplied under SCSP and TSP program of Institute during 2020-21.

Construction of Water Harvesting Poly tank

A 40 cu m (40,000 litre) capacity polytank was constructed during 2020-21 at the HATS Mukteshwar to cater the needs of the water requirement of the experiments/trials.

Rust

Anthracnose

Angular leaf spot

Station trial of garden pea

VL *Lahsun* 2 (Breeder seed)

7. Technology Assessment and Transfer

Krishi Vigyan Kendra, Chinyalisaur, Uttarkashi

Krishi Vigyan Kendra, Kafaligair, Bageshwar

7. Technology Assessment and Transfer

The institute has one KVK at Uttarkashi and another at Bageshwar district for wider dissemination of developed technologies to the farmers of the region. Vocational training programmes are organized by KVKs for farmers and extension workers. These KVKs also serve as active link between research-extension and farmers and provide critical feed back to the ICAR-SAU research system on one hand and extension system on the other. Front Line Demonstrations (FLDs) are conducted to demonstrate latest technology on farmers' fields and field days and training programmes are organized to acquaint farmers with the advances in the field of hill agriculture, provide answers to farmers queries and to suggest ways to enhance their income and living standards.

7.1. Krishi Vigyan Kendra, Chinyalisaur

7.1.1. Trainings

Krishi Vigyan Kendra (ICAR-VPKAS) Chinyalisaur, Uttarkashi has offered 19 training courses for the practicing farmers, farm women, and rural youths on various topics in the disciplines of Horticulture, Agricultural Extension and other running projects with an objective to uplift the socio-economic status of underprivileged farmers through improvement in agriculture production, allied enterprises. Total 596 participants (223 Male and 373 Female) attended the programme (Table 7.1.1). Besides these trainings, two skill development training programmes (Assistnat gardner and Agriculture extension service provider) for 200 hrs duration were organized (Table 7.1.2).

Table 7.1.1. Discipline wise training programme conducted by KVK, Chinyalisaur

Discipline	No. of courses	No. of participants		
		Male	Female	Total
Horticulture	13	155	277	432
Agricultural Extension	3	49	51	100
Sponsored Training Programme	3	19	45	64
Total	**19**	**223**	**373**	**596**

Table 7.1.2. Skill development programme

Title of the Training	Duration	No. of participants		
		Male	Female	Total
Assistant Gardener	200 hrs.	7	13	20
Agriculture Extension Service Provider	200 hrs.	8	12	20

7.1.2. Front Line Demonstrations

Front line demonstrations were conducted at the farmers' field in an area of 25.0 ha under KVK, during *kharif 2020* and *rabi* 2020-21. Total 579 farmers were benefited (Table 7.1.3 & 7.1.4).

Table 7.1.3. Front line demonstration conducted dueing *kharif* 2020

Crop	Variety	Area (ha)	No. of farmers
Horse Gram	VL *Gahat* 19	2.0	108
Maize	VL CM -31	2.0	62
	Total	**4.0**	**170**

Table 7.1.4. Front line demonstration conducted dueing *rabi* 2020-21

Crop/ livestock	Variety	Area (ha)	No. of farmers
Pea	*Vivek Matar* 10, 11, 12	1.0	164
Lentil	VL *Masoor* 514, 126, 133	10.0	210
Wheat	VL *Gehun* 829, 953	10.0	35
	Total	**21.0**	**409**

7.1.3. On Farm Trials

Four on farm trial (OFTs) were conducted addressing different problems under various farming systems (Table 7.1.5).

Table 7.1.5. On farm trials

Title	Crop/ Variety	Treatment	No. of Farmers
Management of *Marssonina* blotch in apple orchard	Apple (Royal Delicious)	3	15
Assessment of high yielding verities of vegetable pea for mid and lower hills of Uttarkashi district	*Vivek Matar* 13, *Vivek Matar* 15	3	15
Assessment of effectiveness of mobile messaging and social media	WhatsApp in bridging the information needs of the vegetables growers	3	45
Control of bitter pit in apples	Apple	3	15

7.1.4. Seed Production

A total of 53.49 quintal seeds of cereals, pulses, oilseeds and vegetables and 1,80,825 seedlings were produced at KVK farm.

7.1.5. Other Extension Activities

- KVK, Uttarkashi on March 6, 2020 celebrated International Women's Day. Eighty ASHA & *Angandwadi* workers were invited to celebrate International Women's week on March 8, 2020.
- One day training programme on "Energy efficiency and energy conservation" was organized on March 6, 2020 and >150 farmers, students and officials were participated.
- World Environment Day was organized on June 5, 2020 and a plantation drive was organized for farmers.
- International Yoga Day was celebrated on June 21, 2020, in which KVK staff and their family members performed various yoga asanas.
- As per the directives given by GoI & ICAR-ATARI, Ludhiana *"Poshak Maha* 2020" (National Nutrition Month) was celebrated during September 1-30, 2020.
- *Hindi Pakhwada* was organised during September 14-30, 2020. *Hindi Diwas* was celebrated on September 14, 2020 & various programs were organized during *Hindi Pakhwada*.
- KVK organized a webinar on "Role of Nutri-gardens in nutrition security of hill community" on September 17, 2020.
- 150th birth anniversary of Mahatma Gandhi was celebrated during September 25 to October 2, 2020 and various activities and events like *Goshti* on Gandhiyan thoughts, cleanliness drive under swachhata abhiyan, quiz competition & *goshti*, speech competition on life of Mahatma Gandhi and lecture series on Gandhian thoughts & Gandhian Philosophy on Agriculture were organized.
- *Mahila Krishak Diwas* 2020 was celebrated by KVK officials along with 32 women farmers at Harshil village on October 15, 2020.
- Organized Integrity oath, extempore competition, essay competition, slogan writing competition, poem recitation competition, speech competition and *Kisan goshti* during observance of Vigilance Awareness Week from October 27 to November 2, 2020.
- On the occasion of "World Soil Day" on December 5, 2020, a total of 98 farmers, students & state officials were participated in the program through online and offline mode and soil health card were distributed to farmers.
- Thirty six B.Sc Agriculture students from different agriculture colleges of Uttarakhand have joined KVK Uttarkashi for 4 month Rural Agricultural Work Experience (RAWE) training.

7.2. KVK Bageshwar

7.2.1. Trainings

KVK (ICAR-VPKAS), Kafligair, Bageshwar organised 22 training programmes including sponsored training (3) programmes. A total of 408 farmers (257 Males and 151 Females) attended the programmes (Table 7.2.1).

Table 7.2.1. Training programmes conducted during 2020

Discipline	No. of trainings	No. of trainees		
		Male	Female	Total
Plant Protection	07	140	13	153
Horticulture	07	78	32	110
Home Science	05	16	67	83
Sponsored Training	03	23	39	62
Total	**22**	**257**	**151**	**408**

7.2.2. Front Line Demonstrations

Front Line Demonstrations (FLD's) on various crops in *kharif* (2020) & *rabi* (2020-21) were conducted on 57.55 ha (22.75 ha in *kharif* and 34.80 ha in *rabi*) benefitting 1,748 farmers (Table 7.2.2). The FLDs during *kharif* 2020 resulted in increasing average yield of various crops from 18 to 58%.

7.2.3. On Farm Trials

- ***Management of purple blotch disease in onion seed production:*** Three sprays of Difenoconazole @ 0.01% at 10 days interval after flowering was

Table 7.2.2. Details of frontline demonstrations on crops and other aspects

Season	Crop	Variety	Area (ha.)	No. of beneficiaries
kharif 2020	Cereals & millets	VL *Dhan* 65& *Vivek Dhan* 154, VL *Dhan*-156, Pusa Basmati 1509, VL *Mandua* 324 & VL *Madira* 207, Maize- *Vivek sankar makka*-45	16.55	496
	Oil seeds	VL *Soya* 47	1.3	102
	Pulses	VL *Gahat* 19	1.9	47
	Vegetables and fruits	Okra (VL *Bhindi* 2), Cauliflower (Snowcrown F1) ,Cabbage (Varun F1)	3.0	140
Sub-total			**22.75**	**785**
rabi 2020-21	Cereals	VL *Gehun*-829, 953(ATMA)	10.5	219
	Oil seeds	Pant Hill Toria-1 (CFLD) and Uttara (ATMA)	10.8	265
	Pulses	VL *Masoor* 133(CFLD) & VL *Masoor* 126 (ATMA)	11.5	375
	Vegetables	VL *Piaz* 3 (ATMA)	1.0	40
		VL *Matar* 12 and GS10	1.0	45
	Mushroom	Button Mushroom (ATMA)	30.0	19
Sub-total			**34.8 ha & 30 q Mushroom**	**963**
Grand Total			**57.55 ha & 30q Mushroom**	**1748**

found best that gave highest onion seed yield of 450 kg/ha followed by four sprays of Mancozeb @ 0.025% at 10 days interval after flowering that yielded 250 kg onion seed per ha, while farmer's practice without use of fungicides gave only 150 kg seed per ha.

- ***Varietal assessment of strawberry:*** Fern variety of strawberry was the top yielder with 75.80 kg per ha yield and 19.5 g (average) fruit weight followed by Chandler (72.50 kg/ha yield and 18.5 g average fruit weight) and Howard 17 (62.80 kg/ha yield and 18.0 g average fruit weight).
- ***Varietal assessment of newly released varieties of vegetable pea:*** GS 10 resulted in highest yield of 81.6 q per ha and B:C 1.94, followed by Vivek *Matar* 12 (75.8 q per ha yield and B:C 1.89) and Vivek *Matar* 15 (71.2 q per ha yield and B:C 1.78).
- ***Effect of Azolla feeding on cow milk production:*** *Azolla* feeding up to 1.5 kg /day considerably increased the milk yield from 10 litre per day to 11 litre per day.

7.2.4. Production of Seed and Bio-products

During 2020, a total of 2,063 kg quality seed of various crops was produced. From various *kharif* 2020 crops 1,225 kg seed has been processed. Vegetable seedlings (10,150), vermicompost (16,000 kg) and milk produced (3,143 l) was produced. A total revenue of Rs 2.29 lakhs was generated.

7.2.5. Other Extension Activities

- KVK organized 2 farmer's field day, on Paddy (Vivek *Dhan* 154) and Soy bean (VL *Soya* 65) crop.
- International women's day was celebrated on March 8, 2020 at KVK campus and a total 78 farm women participated.
- Yoga activities were organized at KVK Bageshwar on the ocassion of 6th International yoga day on June 21, 2020.
- Organized a training programme on "Mushroom Grower and Quality Seed Grower" under Agriculture Skill council of India (ASCI) for 40 participants.

- Organized plantation programme and seedlings of *Rudraksh*, *Chandan*, *Harad*, *Aonla*, *Tejpat*, *Banj*, *Parijat*, *Badi Ilaichi* etc. were planted in KVK premises on *Harela* festival (A State Festival of Uttarakhand) on July 16, 2020.
- Organized *Parthenium* awareness week during August 16-22, 2020 by uprooting Parthenium weed from KVK campus and nearby areas involving rural youth and farmers.
- Various inputs including hybrid *Napier* root slips, small farm tools, agricannon guns and light traps were distributed to the farmers of village Uderkhani under SCSP programme of Assisted ICAR-VPKAS, Almora.
- ***National Nutrition Month:*** KVK, Bageshwar organized various activities under *Poshan Maah* during the month of September 2020. Awareness programmes were organized at Anganbadi Kendra Kafligair, Pansdev, Simsyari, Sainj, Kholseer and Okhalisirod villages. Vegetable seeds were distributed to 130 farm women for establishing the nutri-gardens and farm women were given technical advice on farming practices. KVK, Bageshwar and Uttarkashi jointly organized a webinar on "Importance of nutri-garden for nutritional security of hill community" through online mode on Sepetmber 17, 2020. A total of 245 farmers, farmwomen and Anganbadi workers were participated in the event. Literature and videos were also shared through Whatsapp groups to create awareness among *Anganwadi* workers, farm women and farmers regarding nutrition on daily basis.
- KVK participated in the virtual meeting held on September 29, 2020 for popularization of FARM app organized by Ministry of Agriculture and Farmer Welfare, Govt. of India, New Delhi.
- KVK participated in national webinar on "Natural Farming" organized by NITI Ayog on September 29-30, 2020 and the Youtube link of the same was also shared with farmers.
- Organized *Kisan gosthi* during *Mahila Kisan Diwas* on October 15, 2020 and a total of 25 participants attended the programme.
- KVK participated in virtual *Kisan Mela* 2020 of ICAR-VPKAS with 29 farmers on October 21, 2020.
- ***Swacchata Week:*** KVK organized cleanliness drive around administrative building, farm area, and common public path and also organized poster, poem competition for children on Gandhian thoughts during swachata week during September 26, to October 2, 2020.
- KVK awarded the "Second Best KVK of Uttarakhand (2019)" by ICAR-ATARI, Zone-1 Ludhiana.
- KVK participated in *Vikas Pradarshni of Uttarayani Mela* 2020 at Bageshwar and exhibited new technologies of agriculture among farmers. KVK bagged the First prize for best exibition stall.

7.3. Institute Headquarter

7.3.1. Trainings Organized

Institute organized 16 (9 on campus, 3 off campus, 4 virtual mode) trainings programmes for farmers, agricultural officers benefitting 503 persons during 2020 (Table 7.3.1).

Table 7.3.1. Trainings organized for farmers at the Institute

Topic	District	Duration	Coordinators	No. of Trainees
On Campus Training Programme				
Simant Janjatiya Krishakon Ki Aay Vradhi hetu Krishi vividheekaran (under Tribal Sub Plan of Institute)	Chamoli, Uttarakhand	January 01-05, 2020 (5 day)	Drs. B.M. Pandey, N.K. Hedau and Kushagra Joshi	37
Uchcha Parvatiya Janjatiya Krishakon Ki Aay Vradhi hetu Krishi vividheekaran (under Tribal Sub Plan of Institute)	Chamoli, Uttarakhand	January 01-05, 2020 (5 day)	Drs. B.M. Pandey, N.K. Hedau and Kushagra Joshi	23
Parvatiy Khsetron Hetu Unnat Phasal Utpadan Aur Bhandaran (Under ATMA, Chamoli)	Chamoli, Uttarakhand	January 07-09, 2020 (3 day)	Drs. J.P. Aditya, Anuradha Bhartiya, and Manoj Parihar	30

Improved Agricultural Technologies for Income Enhancement of NEH farmers	Hill districts of NEH region	Ferbrary 11-15, 2020 (5 day)	Drs. Nirmal Hedau, K.K. Mishra and Kushagra Joshi	17
Improved Agricultural Technologies for Income Enhancement of NEH farmers	Hill districts of NEH region	Ferbrary 19-23, 2020 (5 day)	Drs. B.M. Pandey, N.K. Hedau and Renu Jethi	18
Parvatiya Krishakon Ki Aay Mein Vriddhi Hetu Unnat Takniki (sponsored by Agricultural Dept., Pithoragarh)	Pithoragarh, Uttarakhand	Ferbrary 25-27, 2020 (3 day)	Drs. Subanna, and Manoj Parihar	15
Parvatiya Krishakon Ki Aay Mein Vradhi Hetu Unnat Takniki (under ATMA, Pithoragarh)	Pithoragarh, Uttarakhand	Ferbrary 28-March 01, 2020 (3 day)	Drs. R.P. Yadav and Chaudhary Ganesh	22
Unnat Prakratik Sansadhan Prabandhan Takniken (Under SCSP of institute)	Nainital, Uttarakhand	March 02- 06, 2020 (5 day)	Drs. Shyam Nath, Jitendra Kumar and Utkarsh Kumar	25
Parvatiya Krishatron Ki Aay Vridhi Ke Liye Unnat Utpadan Takniki	Pithoragarh, Uttarakhand	December 28-30, 2020	Drs. Kushagra Joshi and Jeevan B	19
Off Campus Training Programme				
Sabjiyon ki kheti main ekikrit nashijeev pravandhan (under TSP of institute)	Malari village of Chamoli district	May 29, 2020 (1-day)	Mr. Amit Umesh Paschapur	44
Rajmash ki kheti main jaiv urvarak ke anuprayog (under NMHS)	Kailashpur village of Chamoli district	May 29, 2020 (1-day)	Dr. Pankaj Mishra	40
Rajmash ki kheti main jaiv urvarak ke anuprayog (under NMHS)	Parasari village of Chamoli district	May 30, 2020 (1-day)	Dr. Pankaj Mishra	52
Virtual Training Programme				
Integrated Pest and Disease Management in Major *Kharif* Crops	Officials from State Agriculture Department, Almora, Uttarakhand	June 25, 2020 (1-day)	Drs. K.K. Mishra, Mr. Ashish Kumar Singh & Mr. Amit Umesh Paschapur	34
Tuta absoluta in Tomato: Symptoms, Identification and Management Strategies	Officials from State Horticulture Departments, Uttarakhand, Himanchal Pradesh, Jammu and Kashmir	July 09, 2020 (1-day)	Dr. A.R.N.S. Subbanna Mr. Amit Umesh Paschapur and Dr. K.K. Mishra	37
Identification and Management of Blast Diseases of Rice and Finger Millet crops	State officials, SMSs from KVKs of North Western and North Eastern Himalayan States	August 04, 2020 (1-day)	Drs. Rajashekara, H., K.K. Mishra, and Mr. Jeevan, B.	52
Fall Armyworm: Symptoms, Identification & Management	Officials from ICAR Institutes, state departments and KVKs of North Eastern Indian Himalayan states	August 07, 2020 (1-day)	Mr. Amit Umesh Paschapur, Drs. ARNS Subbanna & K.K. Mishra	57

7.3.2. Front Line Demonstration (FLDs)

To assess the performance of newly released varieties of small millets, soybean, rice, wheat and maize hybrids at farmers' field, Front Line Demonstrations (FLDs) were conducted in a total of 25.0 ha area across the state benefitting more than 250 farmers.

Maize

During *kharif* 2020, frontline demonstrations of VMH 45, VMH 53, CMVL 55, VLMH 57 and FQH 106 were conducted in Shama (2.0 ha) and Liti (3.0 ha) village in block Kapkote of district Bageshwar. In the FLDs, the yield superiority of VL hybrids ranged from 23.11 to 74.04 per cent (Table 7.3.2.).

Table 7.3.2. Details of maize hybrids and percentage superiority over the local cultivar

Variety	Area (ha)	Location	Yield (q/ha)	% gain over local cultivar
VMH45	5.0	Shama & Liti	32.50-40.20	23.11-56.72
VMH53		Liti	37.20-40.10	45.88-61.04
VLMH57		Liti	32.20-41.50	43.11-70.78
FQH106		Shama & Liti	34.20-37.40	41.91-57.14
CMVL 55		Liti	36.80-40.90	61.40-74.04

Rice

The Front Line Demonstrations of released varieties *viz.*, VL *Dhan* 68 under irrigated condition and VL *Dhan* 156, VL *Dhan* 157, VL *Dhan* 158 under rainfed upland condition were conducted during *Kharif* 2020 among 64 farmers in 6.0 ha area of 5 villages of Almora District. The performance of improved cultivar was higher than the local checks namely China 4, Shyamgiri, Dhurbasmati and Thapachini.

Soybean / black soybean

Front Line Demonstrations of improved soybean and black soybean varieties (VL Soya 89, VL Soya 47, VL Soya 63, VL *Bhat* 65 and VL *Bhat* 201) with recommended package of practices were conducted involving 81 farmers in approx 5.0 ha area at village *Mujholi* of Almora district during *kharif* 2020.

Improved black soybean variety VL *Bhat* 201 at Mujholi village, Almora

Horsegram

Front Line Demonstrations of improved horsegram varieties (VL *Gahat* 8, VL *Gahat* 10, VL *Gahat* 15 and VL *Gahat* 19) with recommended package of practices were conducted in approx. 2.0 ha area involving 35 farmers at village *Kasoon* of Almora district during *kharif* 2020.

Improved horsegram variety VL *Gahat* 19 at Kasoon village, Almora

Finger millet

Front line demonstrations of four improved varieties of finger millet (VL *Mandua* 376, VL *Mandua* 379, VL *Mandua* 352 and VL *Mandua* 380) were conducted in 7.0 ha at four villages (Mangalta, Jamradi, Shakuni and Melta) of district Almora. The improved varieties VL *Mandua* 376, VL *Mandua* 379, VL *Mandua* 352 and VL *Mandua* 380 along with management practices exhibited yield advantage of 40.3, 33.2, 31.7 and 34.3% respectively over the farmers practice.

FLD of VL *Mandua* 379 at Sokuni village

7.3.3. Field day

Maize

Maize Field Day was organized at Shama (Kapkote, Bageshwar) and Liti (Kapkote, Bageshwar) on October 3, 2020.

Maize hybrid VLMH 57 at Liti

Maize field day at Liti village

Soybean and black soybean

A field day on soybean was organized on October 4, 2020 at *Mujholi* village, Almora to generate awareness among farmers about improved varieties, production technology, crop protection, value addition and marketing options. A total 30 farmers participated in the event and visited the performance of improved soybean and black soybean varieties in the fields.

Farmer's participatory varietal selection of pigeon pea

Participatory varietal selection (PVS) was conducted with the objective to identify the varietal need of hill farmers' and pre-selection of suitable pigeon pea material from extra early (indeterminate) and super early pigeon pea (both determinate & indeterminate) trials at experimental farm, ICAR-VPKAS, Almora during *kharif* 2020. Trials were evaluated by farmers (69) from 20 different villages of Almora district at full pod formation stage on October 19 & 21, 2020. Farmers preferred super early determinate types the most based on their suitability for fitting in their existing cropping system owing to early maturity (110-115 days), ease for intercultural operations and safety from wild animals due to short height (up to 1 meter) and compact bushy nature, profuse bearing and synchronous maturity.

Farmers participatory varietial selection in pigeon pea

Finger millet

Finger millet field day was organized at Mangalta to demonstrate farmers the benefits of adopting high yielding short duration varieties, management technologies and value-added products for use in the household and for sale and profitability of finger millet in comparison to major crops. During the field days 45 farmers, 70 percent of which were women belonging to Mangalta and Jamradi were present. Utility of Vivek millet thresher was demonstrated at all the villages to reduce the drudgery involved in post harvest management of finger millet.

In addition, a demonstration on making finger millet namkeen to self help group of women farmers of Mangalta was given to start it as an entrepreneurship with the brand name of "*Jaivik mandua* (*Ragi*) *ki namkeen*". Sellf help group of women's were also encouraged to make it compulsory to prepare *mandua namkeen* as an essential dish during any auspicious function like marriage, naming ceremony and engagement in the family or village.

Finger millet field day at Mangalta

7.3.3. Mera Gaon Mera Gaurav

Mera Gaon Mera Gaurav – an innovative initiative has been planned by government of India to promote

Activities organized under MGMG by the Institute

Name of activity	No./quantity	No. of farmers participated/ benefitted
Visit to village by teams	08	159
Interface meeting/ *Goshthies*	06	125
Trainings conducted	00	00
Mobile based advisories	61	993
Literature support provided	197	197
Awareness created	14	383
Linkages developed with other agencies	04	176
Seeds provided	0.25(Finger millet and barnyard millet) 0.07 (onion) 50 (Wheat)	50 06 40 13
Millet thresher	10	60
VL Light trap	10	10

Details of demonstration conducted under MGMG by the Institute/SAU

Title of demonstrations	No. of demonstration	Area covered under emonstration (ha)/ number of units, etc.)	No. of farmers benefitted
Demonstration of improved variety of wheat VL *Gehun* 953 at farmer's field.	03	0.60 ha	03
VL light Trap	05	10 units	10
Fodder tree/ grass plantation	02	35 plants	15
Demonstration of onion variety VL *Piaz* 3	06	0.2 ha	06
Demonstration of VL Light Trap and *Bacillus cereus* WGPSB2 talc formulation.	05	01-02 ha	05
Demonstration of VL *Mandua* 324 (Finger millet), VL 376 (Finger millet), VL *Madira* 207 (Barnyard millet) at farmer's field.	15	0.3 ha	15

Disease diagnosis in cauliflower

Distribution of talc based formulation of *Bacillus cereus* WGPSB2 and VL Light trap for white grub management

Details of Input support provided under MGMG by the Institute/SAU

Type of Input Support Provided (Seed, planting material, technology, fertilizers, etc.)	Quantity (kg/No.)	Area (ha)	No. of farmers benefitted
Demonstration of VL Light trap	10.00	02-04	10
Demonstration of Onion VL *Piaz* 3	0.06	0.20	06
Demonstration of VL *Mandua* 324 and VL *Mandua* 376 (Finger millet), VL *Madira* 3207 (Barn yard millet)	15.00	0.30	15
Demonstration of VL *Mandua* 376 and VL *Mandua* 379 Finger millet varieties	25.00	0.06	50
Demonstration of VL *Gehun* 953, VL *Gehun* 967 and VL *Gehun* 907	50.00	1.20	13
Demonstration of Onion	0.01	0.12	35

Goshthi on improved wheat cultivation practices at village Amsyari

Seed distribution to farmers at village Amsyari

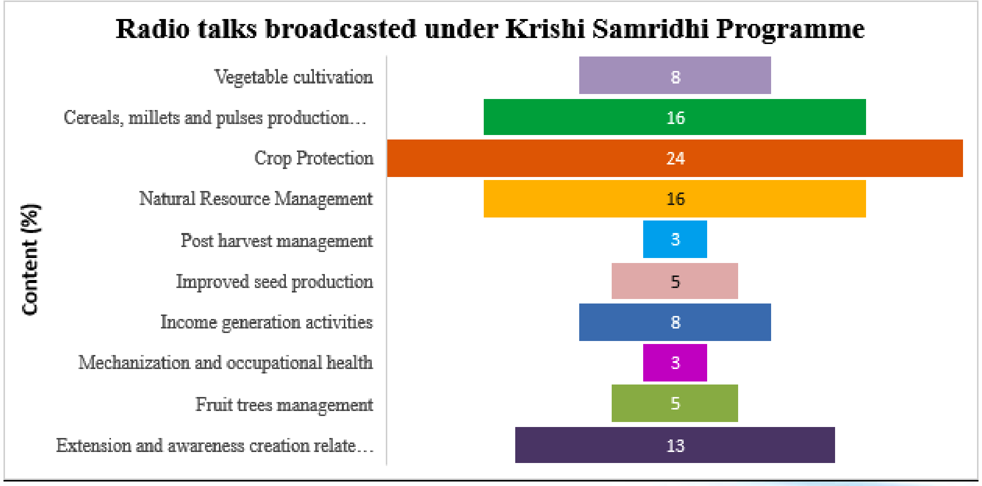
the direct interface of scientists with the farmers to hasten the lab to land process. In synchronization to the programme, five interdisciplinary team of scientist have been formed at ICAR-VPKAS, Almora, who visited the villages adopted in 5 clusters of Uttarakhand to cater the agriculture related needs of the farming communities. In the year 2020, 25 villages from five blocks of Almora district were visited regularly by the teams. The areas of national priority likewise soil and water conservation, mechanization, agricultural productivity, insect-pest management measures were taken care of. Due to the covid-19 pandemic as the social distancing measures were imposed, the teams utilized ICT tools to provide mobile advisory to the farmers in their respective clusters.

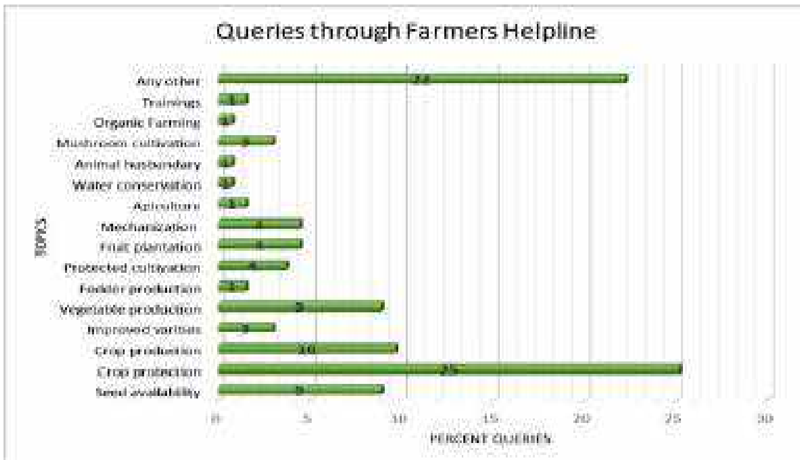
7.3.4. *Krishi Samridhi* Programme

Radio based programme-Krishi Samridhi

Krishi Samridhi, a radio based programme, an initiative of ICAR-VPKAS, Almora for promoting Good Agricultural Practices among farmers. It was a live, 10 minutes syndicated talk-based radio programme for farmers of hill districts of Uttarakhand in which experts from the Institute share up-to-date information on crop cultivation, technology adaptation, socio-economic improvement and various agricultural schemes. A list of need-based topics was prepared as per its importance in relation to seasonal farming operations. An expert, mainly the Scientists and Subject Matter Specialists of ICAR VPKAS, Almora, and its *Krishi Vigyan Kendras,* records an informative talk on agriculture and allied activities which is broadcasted every Sunday at 1910 hrs.

The programme covers a range of topics and integrates scientific information with consideration of, and reference to, knowledge, and interests of the intended audience and seasonality. Content analysis of the talks broadcasted shows that thirty eight talks were broadcasted on information related to crop protection (24%), vegetable cultivation (8%), cereal, millet and pulses production techniques (16%), natural resource management techniques (16%),





Distribution of queries *via* farmer's helpline

post-harvest management (3%), improved seed production (5%), mechanization and occupational health (3%), fruit trees management (5%), income generation activities (8%) and extension and awareness generation related aspects (13%).

7.3.5. Krishak Helpline

Krishak Helpline

To facilitate farmers, the institute offers a toll-free helpline service to answer the queries raised by hill farmers on various aspects like crop varieties, seed availability, insect-pest and disease management, schemes, etc. Farmers can reach agriculture experts by dialling 1800-180-2311 on working days during 10:00 am to 5:00 pm. In year 2020, 135 queries were received from farmers, majority of which were related to crop protection (25%), crop production (10%), vegetable cultivation (9%), seed availability (9%), other related information (22%), protected cultivation (4%) and apiculture (4%).

Agro-advisory through ICT platforms

Agro-advisories are provided to farmers through need based SMS services, m-*Kisan* portal and *Krishi Samridhi* Radio programme. Informations were sent to farmers on different contents like varieties, crop protection measures, nutrient management, farmers fairs/field days, seed production, government schemes benefiting registered farmers. National level agro-advisories prepared by ICAR were also issued to farmers through SMS service and whatsapp during lockdown period due to COVID-19. Institute also issued various advisories related to safety measures with current farming operations such as harvesting, post-harvest management. During lock down period, 8 crop advisories for farmers were displayed in institute website as well as various Whatsapp groups for information dissemination. Besides, 194 advisories sent to 1042 farmers through Whatsapp groups, 118 phone calls replied through help line, 7 messages through mKisan to 127064 farmers; 40 need based messages to 2606 farmers through phone, 2 voice messages to 269 farmers were sent during reporting period.

Mobile apps

VPKAS *Phasal Guru*

VPKAS *Phasal Guru* is an official app from ICAR-VPKAS, Almora which showcased all the location specific crop varieties developed for hill agriculture, specifications and package of practices. The app can be downloaded freely from Google Play store. Users can communicate with the developer through feedback option for any suggestions and queries. The application is available both in English and Hindi language.

https://play.google.com/store/apps/details?id=vpkas.phasalguru.sense

VPKAS *Krishi Samriddhi*

VPKAS *Krishi Samridhi* app is an official app from ICAR-VPKAS, Almora which offers archived broadcasts of the *Krishi Samridhi* programme broadcasted through AIR, Almora for hill farmers of Uttarakhand. It is a set of pre-recorded radio talks by agricultural scientists. The app can be downloaded freely from Google play store. The application is available both in Hindi and English whereas, audios are in Hindi only.

https://play.google.com/store/apps/details?id=vpkas.krishi.samriddhi.sense

Mobile abbs at ICAR KRISHI Portal

White Grub Management

VPKAS White Grub Management is an official app from ICAR-VPKAS, Almora which provide information about identification of white grub, its life cycle and its management using light traps and entomopathogens.

https://play.google.com/store/apps/details?id=vpkas.whitegrub.management.sense

Social Media Platforms

Social media is the most recent form of digital communication. Social media platforms like facebook and twitter have unique opportunity for institutes to reach an increased number of audience in lesser time and with reduced resources. ICAR-VPKAS has its official facebook page https://www.facebook.com/www.vpkas.icar.gov.in and twitter account https://twitter.com/IVpkas to enhance its visibility in social media. Information on different field level activities, technologies developed by institute and other information are being updated regularly.

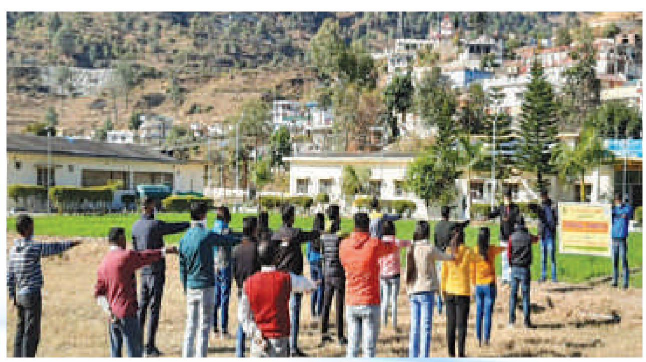
Facebook page

Twitter page

7.3.6. *Swachhata Pakhwada*

On December 16, 2020, Director, ICAR-VPKAS lead the reading of the pledge by all employees of the institute. He further explained about the activities to be organized during *Swacchta Pakhwada* (December 16-31, 2020). All employees of both the KVKs of ICAR-VPKAS, Almora also read the pledge.

Swachhata pledge at main campus, Almora and experimental farm, Hawalbag



Swachhata pledge at KVK, Uttarkashi and KVK, Bageshwar

At experimental farm, Hawalbag plantation of the trees was carried out by the Institute employees.

Tree plantation by institute employees

A cleanliness drive was carried out at ICAR-VPKAS, Almora office campus, its experimental farm and its KVKs at Bageshwar and Uttarkashi with active participation of staff on December 17, 2020. Cleaning work was done in office premises and corridors. A committee comprised of Senior Administrative Officer, Finance & Accounts Officer, Drawing and Disbursing Officer, Officer-in-charge, Store and Officer-in-charge, Operation and Maintenance reviewed the progress on weeding out of old records and disposing of old and obsolete furniture at store of ICAR-VPKAS, Almora. Moreover, digitalization of office records and e-office implementation were reviewed by administrative office and Finance and Accounts officer.

At various villages adopted by the institute and its KVKs under *Mera Gaon Mera Gaurav* programme cleanliness drive was carried out on December 18, 2020,. Farmers in the village *Sinduri,* district Bageshwar, Uttarakhand were sensitized about the cleanliness of vegetable crops as well as to regularly clean vegetables while consuming them. KVK, Uttarkashi issued an advisory to the farmers on *mKisan* app advising them to practice COVID-19 precautionary measures like wearing mask, following physical distancing & maintaining hand hygiene.

Sensitization of farmers about the cleanliness of vegetable crops

On December 19, 2020, cleanliness drive was carried out at ICAR-VPKAS, Almora office campuses, residential colonies and its KVKs at Bageshwar and Uttarkashi with active participation of staff. A committee reviewed the progress of

Cleanliness drive at office campus and residential colonies

cleanliness and sanitation drive within campus and residential colony and road-side of ICAR-VPKAS. In addition, staffs were sensitized about the importance of biodegradable and non-biodegradable waste disposal.

A demonstration was conducted for preparation of vermi-compost from the kitchen wastes for the members of residential colony of ICAR-VPKAS experimental farm, Hawalbag on December 20, 2020. Plastic wastes were collected and disposed off to create the experimental farm as plastic-free zone. The importance and significance of cleanliness were deliberated to the farmers in village Lakhani, district Bageshwar adopted under SCSP programme of the Institute.

Demonstration on preparation of vermi-compost from the kitchen wastes

***Swachhta* awareness among SCSP adopted villagers from Lakhani, Bageshwar**

On December 21, 2020, *swachhta* campaign was conducted at the experimental farm, hwalbag and farms of KVKs, Uttarkashi and Bageshwar for cleaning of sewerage and water lines. Waste management activities, disposing green waste and compost in tetra-vermi-beds and vermi-compost pits at KVKs farms were also carried out.

Cleaning of sewerage and water lines & waste management activities

A *sangosthi* on disposal of various types of waste in agriculture was organized at experimental farm, Hawalbag on December 22, 2020. A presentation was made by Mr.

***Sangosthi* on disposal of various types of waste in agriculture at Hawalbag and KVK**

Keshav Nautiyal on safe disposal of the waste in experimental farm. A total of 60 scientists, technical staff, administrative and supporting staff have participated in the programme.

Kisan Diwas was organized at experimental farm, Hawalbag on December 23, 2020. This special day is celebrated every year to promote awareness amongst people about the importance of the farmers to the society. *Kisan Gosthi* was organized in which scientists and farmers shared the knowledge on various aspect of farming. Farmers shared their experiences and problems in farming and made the scientists aware about the problems faced by them while adopting the new technologies. Dr. B.M. Pandey, Pr. Scientist participated in *Kisan Diwas* at KVK, Matela, Almora and made farmers aware about ICAR-VPKAS technologies and farmer's bill.

A Scientist-Farmer-Interaction programme was also organized by KVK, Uttarkashi and at KVK, Bageshwar. The KVK officials informed the farmers

about the importance of celebration of *Kisan Diwas* and the vision of Ex. Prime Ministers, Lt. Shri Chaudary Charan Singh and *Bharat Ratna* Lt. Shri Atal Bihari Vajpayee. The farmers' fraternity was encouraged about importance and benefits of scientific cultivation. Production of FYM and vermi-compost preparation was also discussed. Recycling of biodegradable waste and waste water utilization in agriculture and horticulture system was also promoted among the participants. Fodder cutting from dual purpose variety VL *Gehun* 829 was demonstrated to the farmers at KVK, Bageshwar.

Swachhta awareness program was organized among the students of Model Government Inter College, Hawalbag, Almora on December 24, 2020. All the students were briefed about *Swacchta* programme of the country as well as *swacchta* at individual level. They were also told about importance of cleanliness and management of Agricultural wastes. Students also shared their views on *Swacchta*. Student's demonstraed model based on *Swacchta*. KVK, Uttarkashi and Bageshwar were also organized awareness programme amongst farm women. Programme emphasis on preparation of farm yard manure, vermi-compost and management of farm wastes etc.,

Goshthi* organized on *Kisan Diwas

Swachhta **awareness program among students of Model Government Inter College, Hawalbag, Almora**

On December 25, 2020, various programs *viz.,* cleaning of public places, nearby selected spots and tourist places were carried out by scientists and staff. All the staffs actively participated in cleaning of Kosi river near experimental farm, Hawalbag. *Krishi Vigyan Kendra*, Kafligair, Bageshwar also carried out cleaning campaign in nearby market in Kafligair.

Cleaning of public places by institute staff

Under the *Swacchta Pakhwada* various competitions *viz.*, drawing, and quiz were organized on December 26, 2020 at *Krishi Vigyan Kendra* (ICAR-VPKAS), Uttarkashi, and Bageshwar online and offline quiz on cleanliness and sanitation among B.Sc. agriculture RAWE trainees. The awareness on cleanliness and its importance was created among the villagers in KVK, Bageshwar.

Awareness about cleanliness and sanitation and competition among students

In continuation of ongoing *Swachhta Pakhwada*, a special virtual drive was organized by ICAR-VPKAS, Almora and its KVKs *i.e. Krishi Vigyan Kendra* (ICAR-VPKAS), Uttarkashi and Bageshwar on 12th day of the campaign on December 27, 2020. Awareness messages were shared among various groups of farmers and rural youth on importance and significance of Cleanliness & sanitation via WhatsApp messages. In the group messages information regarding recycling of organic waste and avoiding the usage of polythene was also circulated. Reuse of domestic waste by means of compositing was also encouraged.

Sharing Awareness messages among various groups of farmers & rural youth

A group of ICAR-VPKAS employees participated in the *Swachhta Pakhwada* on December 28, 2020. The water storage tank, kitchen gardens, sewage, drainage line facilities and chocked water pipes were cleaned in residential colonies of Hawalbag campus. A campaign on cleaning of sewage and water lines in residential colonies and water harvesting and management in agriculture was carried out. A campaign on cleaning of sewerage and household drainage lines was held at village *Bhadangaon* of Uttarkashi district by KVK, Uttarkashi, in which local community and children participated. They were acquainted with recycling of waste water for the domestic purpose like its use in the kitchen garden and horticultural purposes. Furthermore, residents of the village were also introduced to the technology of rainwater harvesting.

On December 29, 2020, all employees visited waste disposal sites in office premises and participated in campaign with emphasis on safe disposal of biodegradable and non-biodegradable wastes. At KVK Uttarkashi staff, RAWE trainees and field workers visited waste disposal sites in office premises and participated in campaign. Trainees were informed that monitoring and supervising waste disposal is mandatory and foremost activity. Collection of wastes, its processing & recycling the waste from biodegradable portion like paper material, food waste, vegetable peels, garden waste, egg shells etc. was also emphasized.

Awareness on safe disposal of Biodegradable and non-biodegradable wastes

ICAR-VPKAS, Almora celebrated *Swacchta Pakhwada* on December 30, 2020 with involvement of VIP and press & media personnels. To accelerate the efforts of achieving more awareness regarding importance of cleanliness & sanitation, Chief Guest Sri Prakash Chandra Joshi, Chairman, Nagarpalika, Almora and special guest, Sri Hem Tiwari, Ward member, Vivekanandpuri, Almora addressed the participants. Sri Joshi told that the Institute has taken lead in creating awareness amongst the local people of Almora and has become the source of inspiration for local people. The institute has adopted Badreshwar spring (*naula*) and cleaned water storage tank, drainage line facilities, floors, roof, grasses, garbage etc. in catchment area of *Naula*. Special guest Sri Hem Tiwari asked all the participants to learn about cleanliness from the Institute. Dr. Lakshmi Kant, Director, ICAR-VPKAS emphasized that institute has inculcated the *Swacchta* since inception of the institute. He asked all the persons to inculcate cleanliness into their wards since their childhood.

Krishi Vigyan Kendra, Uttarkashi and Bageshwar also celebrated the occasion. Special guests for the occasion; Medical Officer In-Charge, Community Health Centre, Chinyalisaur and Senior Veterinary Officer from Chinyalisaur Veterinary Hospital addressed the participants by audio conference (offline mode) and shared their messages. Motivational speech was given by the guests (by audio conference) regarding significance of hygiene in day to day life.

Officials from KVK Uttarakshi, visited the village Aleth and promoted awareness regarding sanitation and cleanliness. A discussion on importance of soil testing and maintaining soil health was also promoted among the participants. Along with the officials there were about 100 more participants from the village community. The activities undertaken during *pakhwada* were widely popularized by newspapers.

Cleaning of premises and address by chief guest Sri Prakash Chandra Joshi Chairman, M.C. Almora

ICAR-VPKAS, *Swachhta Pakhwada* in social media

7.5. Tribal Sub Plan

During the reporting period village clusters in three districts of Uttarakhand *viz.*, Almora, Chamoli, and Dehradun and Rajauri district of Jammu were adopted by the institute under Tribal Sub Plan with the objective of socio-economic development of the tribal communities of Uttarakhand. A number of programmes were organized at the institute as well as at farmers' fields and the brief description of these programmes is as follows:

7.5.1. Farmer Trainings

Training on agricultural diversification for income enhancement

Two five days training programmes on "Agricultural Diversification for Income Enhancement of Farmers of High Hills and Border Area" were organized by institute during January 1-5, 2020. A total of 60 progressive tribal farmers from 4 villages of Joshimath Block of Chamoli district participated in the training programmes. The farmers were imparted information on improved varieties, improved crop production and crop protection technologies, seed production, small tools and farm machinery, mushroom production and bee-keeping.

Training of Border Farmers

Exposure Visit of Trainees to CITH RS

A visit to ICAR-CITH Regional Station, Mukteshwar was also organized to give them practical exposure for training and pruning techniques in temperate fruits. They were also sensitized on '*Swachh Bharat Abhiyaan*'. A live demonstration of preparation of soymilk and tofu was also given, which was much appreciated by the farmers. The farmer groups were also acquainted with the technique of making coal-briquettes from pine needles.

On farm training programmes and demonstrations

Rajma is an important crop cultivated in major TSP clusters (Niti and Mana village clusters of Uttarakhand). The crop was severely infected by black cut worm (*Agrotis* spp), and the per cent infestation was increasing over the years from 40-60%. This forced farmers to go for re-sowing of the crops in several years. So, the survey was conducted to collect the insect samples and identify the insect pest morphologically. Based on morphological characters the species of cut worm was identified as *Agrotis segetum*, which is a major cut worm species in temperate regions of Uttarakhand and Himachal Pradesh infecting large number of vegetable and pulse crops. Keeping in view, a training programme was organised at Malari on Integrated Pest Management in which 44 farmers and farm women participated. Farmers were suggested the following pest management practices:

Training Programme on IPM at Malari with covid SOP

Cut worm larvae feeding on plants

Cut worm adult

1) Seed treatment with Thiomethaxam 70% WS at 4ml per kg seed 2 hours before sowing and shade drying the treated seed before sowing. (This treatment reduced the pest damage in early crop growth stages by up to 75% and protected the crop up to 25 days)

2) Foliar spray of Chlorpyriphos 50% + Cypermethrin 5% at 2ml per litre water 25 days after sowing could effectively kill the larvae.

3) Food-bait trap- 3 kg rice bran + 1 kg Jaggery + 2 litre water, mixed thoroughly and allowed to ferment over night. Next day the food is poisoned with monocrotophos 150ml and the poisoned bait is made into balls and broadcasted in the fields.

In the month of October, a follow-up visit was undertaken to assess the efficacy of the above treatments. The farmers found the first treatment very effective and safe for wild life of the areas.

Follow-up of vocational training programme

A residential 15-day vocational training programme on skill upgradation (beauty culture and tailoring) of tribal women was organised by ICAR VPKAS, Almora in 2018. After successfully completing the training programme, 06 women of Dehradun district have started tailoring in their respective villages. In February 2020, a programme on "*Kaushal Vikas Se Ajeevika Unnayan Evam Yantrikaran Se Shram Nyunikaran*" was organized at Dhanpau village of Kalsi block. Sewing machine were distributed among these tribal farmers for a study under Fakhruddin Ali Ahmed Award - 2018 received by the institute. Besides, chaff cutters (2 units) and maize shellers (2 units) were also given to tribal farmers' collectively.

Follow up of vocation training programme

Distribution of sewing machine at Dhanpau village

7.5.2. Krishak Goshthis and Farmer-Scientist Interactions

Various farmer-scientist interface and pre-sowing camps were organised in Gamshali, Mana and Kailashpur village during May mainly on seed production of French bean and mechanization in which 65 farmers participated. The scientists interacted with the farmers in the villages, took feedback on the demonstrations given last year and briefed on the demonstrations to be conducted. Farmers scientist interaction was also organized in Syahi Devi village of Almora district, in which 18 farmers participated. Maize seed was distributed among participants.

Farmers scientist interaction at Gamshali

Farmers scientist interaction at Kailashpur village

Vegetable seeds (garden pea, summer squash, and coriander), agro-chemicals and small tools were distributed among the all tribal farmers of these villages. In all three villages, the farmers were also sensitized to protect themselves from COVID-19 and masks were distributed to all participant farmers of the cluster.

7.5.3. Exposure Visits

An exposure visit of 4 progressive farmers was conducted during the PUSA *Krishi Mela* organized at ICAR-IARI, New Delhi in February 2020. The farmers were exposed to progressive agricultural technology including crops/seed production, water conservation technology, post harvest processing technology, and other technologies developed by various government/ private sector organization.

Participation of tribal farmers in PUSA *Krishi Mela* at ICAR-IARI New Delhi

Arrangements were also made for exhibition of traditional craft and other exhibits of their region. Hon'ble Union Minister of Agriculture Shri Narendra Singh Tomar and other dignitaries visited and appreciated the exhibits in the stall.

7.5.4 Technology Dissemination and Adoption

A total of 16.60 q seed of vegetable pea (Var. Arkel, GS 10, VL *Sabji Matar* 13 and VL *Sabji Matar* 15), 1.25 kg seed of summer squash, 120 kg seed of French Bean (VL Bean 2), 30 kg seed of coriander, 800 g cauliflower, 2.2 kg cabbage, 20 g cucumber were distributed among tribal farmers of various villages of Chamoli district. About 30.0 q seed of *Vivek* Maize Hybrid 45 was delivered to 3 clusters (Dhankpau-Lakhwad and Kwanu cluster in Uttarakhand and Rajouri cluster in Jammu) for *kharif* 2020 demonstrations.

During the follow-up visit in October the response of VL *Sabji Matar* 13 and VL *Sabji Matar* 15 was found very well in Niti valley of Chamoli district compared to Arkel and NSC 10 variety of garden pea. Demonstrated varieties of cabbage, cauliflower, quinoa and amaranth were highly appreciated by the farmers. Performance of VL *Piaz* 3 in Parsari and Merag was recorded excellent and the variety was highly appreciated due to its longer keeping quality.

During *rabi*, demonstrations on wheat, barley, garden pea and onion were laid out in Chamoli, Almora and seed of wheat varieties was delivered to Dhanpau-Ladhwad clusters of Dehradun district of Uttarakhand and Rajouri district of Jammu and Kashmir.

Demonstrations of vegetable crops in Merag and Parsari village of Chamoli district

7.5.5 Distribution of Agro-inputs

For *rabi* 2020-21 demonstrations, 53.1 q seed of wheat (VL *Gehun* 829, VL *Gehun* 892, VL *Gehun* 907, VL *Gehun* 953 and VL *Gehun* 967), and 2 q of barley (VL *Jau* 118) was made available to the tribal farmers of Chamoli, Dehradun and Rajouri districts. Fertilizers (NPK 200 kg, Urea 270 kg, MoP 100 kg.) for maize cultivation and 40.8 kg Emamectin Benzoate for controlling Fall Army Worm in maize in Dehradun were also distributed. Six hundred-sixty sets of small tool kit (including *kutala, darati, hand fork, hand hoe, garden rake*, and *line maker*) were distributed among farmers of Chamoli and Dehradun cluster. Distribution of neem oil was done among tribal farmers of the organic villages of Chamoli.

7.5.6 Establishment of Farmer Participatory Seed Production System

Rajmash is very important cash crop of remote village (Malari, Gamshali, Niti etc.) of Niti Valley.



Distribution of seed, small tools and Syahi hal in various tribal villages


Distribution of insecticide Emamectin benzoate and wheat seed


Farmers Participatory Seed Production of French Bean at Kailashpur village

The climatic conditions for taking seed crop of French bean is very congenial and hence as part of the institute's work plan to establish a farmer-participatory seed production system at local level, seed production programme was undertaken at Kailashpur (3300 amsl) in Niti Valley during *Kharif*. A total of 887 kg seed of French bean variety VL *Bean* 2 was procured from six Self Help Groups of the village.

7.5.7 Initiatives Taken during COVID 19 Pandemic

During Covid 19 pandemic, whatsapp group of farmers named as "*Vivek Krishi Sandesh*" were formed for Merag, Parsari, Kwanu, Dhanpau and Syahi Devi. Through these groups, advisories were sent to the tribal farmers on crop production, insect-pest management and disease identification and its control. Farmers use this platform for posting their queries related to agriculture, share the photographs of the problems to the experts, and get scientific advice for its remedy. In total 45 advisories has been sent to 4 farmers groups.

7.6. Scheduled Caste Sub-Plan Programme (SCSP) Programme

Fabrication of polyhouses

Under SCSP, 27 naturally ventilated polyhouses (18.2 m long, 5.5 m wide with 2.3 m height on sides and 4.0 m height in the center) were fabricated at Lakhani village of Bageshwar district. The total area of each polyhouse was 100 sq m. Farmers have sown vegetable pea crop in these polyhouses for seed production.

Vivek Millet Thresher-cum-Pearler and Agri-Canon distribution

A total of 35 units of Vivek Millet Thresher-cum-Pearler were distributed to scheduled caste (SC) farmers under SCSP Programme in the Almora, Bageshwar and Uttarakashi districts. The farmers

made aware about the use of Vivek Millet Thresher-cum-Pearler in place of traditional method of threshing and pearling. January 3, 2020, the Chief Minister, Uttarakhand distributed Vivek Millet Thresher-cum-Pearler to the SC Farmers at ICAR-VPKAS, Almora. 109 Agri-canons were also given to the farmers for protection of crops from monkey.

Farmers' training program under SCSP

A 5-days training program on improved natural resource management technologies for hilly region was organized in experimental farm, Hawalbag during March 2 to 6, 2020 under the Scheduled Caste Sub-Plan (SCSP) programme. A total of 25 progressive farmers from the Ramgarh and Ramnagar blocks of Nainital district of Uttarakhand participated in the training program. The farmers were made aware about the technologies developed by ICAR-VPKAS and how best farmers can enhance their livelihood by adopting improved agricultural technologies in an integrated way. The training program mainly focused on improved natural resource management technologies for hilly region while imparting knowledge on overall crop production technologies for hills. The small farm tool kits and Agri Canons were distributed to the trainee farmers.

5-day SCSP farmers' training program

Training programmes on mushroom production

Three one-day trainings programme on "Mushroom Production" were organized for the SC farmers of Uderkhani, Lob and Lakhani on 27 October, 29 October and 18 November 2020 by the KVK, Kaafligair.

Distribution of small farm tool kit, VL Metallic Plough and VL Polytunnel

As a replacement of wooden farm tools, iron made 698 small farm tool kits and 161 VL Metallic Plough were given to the farmers to increase the efficiency of their farm operations. Farmers were satisfied with the VL line maker and shown keen interest in it.

Distribution of small farm tool kit, VL Metallic Plough

Line Sowing at farmer's field Bg line maker

VL Light Trap and Bacillus cereus WGPSB2 Powder Distribution

Two hundred seven VL Light Traps were installed in the fields of farmers in different villages of Uttarakhand. The farmers were also given 131 kg powder of *Bacillus cereus* WGPSB2 for effective control of white grubs. A demonstration on rat control was conducted in Lakhani village.

Distribution of VL light trap

Distribution of *Bacillus cereus* WGPSB2

Seed and seedling distribution

The seeds of improved varieties of vegetable crops (13), wheat, lentil, seedlings of vegetables were distributed to the farmers.

Crop	Variety	Quantity
Wheat	VL *Gehun* 829	100 kg
Wheat	VL *Gehun* 892	100 kg
Wheat	VL *Gehun* 907	500 kg
Wheat	VL *Gehun* 967	100 kg
Wheat	VL *Gehun* 2014	50 kg
Wheat	VL *Gehun* 3004	50 kg
Lentil	VL *Masoor* 129	100 kg
Lentil	VL *Masoor* 133	200 kg
Vegetable pea	Arkel	1050 kg
Vegetable Pea	Vivek *Matar* 12	80 kg
Radish	Dunagiri Gol	1.2 kg
Lahi	Haathikaan	8 kg
Methi	PEB 1	58.0 kg
Dhania	PD 1	37 kg
Cauliflower seedlings	-	9000 seedlings
Onion seedlings	VL *Piaz* 3	50000 seedlings
Hybrid napier grass	Hybrid napier	1500 kg
Fodder saplings	-	500 No.
Okra	Arontika	127 pkts (50 g each)
French bean	NSC French	156 pkts (250 g each)
Capsicum	Raja	100 pkts (10 g each)
Radish	Hybrid Farm Sona	400 pkts
Bottle guard	-	100 packets
Azola	-	5 kg

Distribution of seed and seedling farmers

Polytank construction

Under SCSP Programme, 27 polytanks were constructed in the Darim village of Nainital district.

Farmers are using these polytanks for irrigation especially in vegetable crops.

Incubation centre–cum-fabrication unit

During 2020, the 326 VL Polytunnels and 5 VL Pedal operated hand wash units were fabricated. The centre has been established to update the skill of local blacksmiths/artisans and to train the unemployed youth of the Scheduled Caste (SC) in the field of mechanization.

Fabricated polytunnels

Hands free hand washing machine

Field visits and interaction meetings with farmers

Field visits and interaction meetings with farmers

Field visits were conducted to the SCSP villages/ sites and discussion was made on major problems faced by the farmers. To address the problems of the farmers a plan was made and baseline survey of the farmers was also conducted during these visits.

Date	Village	District	Purpose/remarks
January 15, 2020	Kabhari	Almora	*Krishak Goshti*-cum-Farm Tool and Vegetable seed distribution
May 19, 2020	Different villages of Garur block	Bageshwar	For site/village selection
May 22, 2020	Different villages of Bageshwar block	Bageshwar	For site/village selection
May 27, 2020	Different villages of Garur and Bageshwar blocks	Bageshwar	For site/village selection
June 4, 2020	Different villages of Garur block	Bageshwar	For site/village selection
June 11, 2020	Different villages of Garur block	Bageshwar	For site/village selection
July 11, 2020	Darim	Nainital	GPS points of polytanks
July 17, 2020	Uderkhani	Bageshwar	Seed distribution and VL Light trap installation.
July 24, 2020	Lakhani	Bageshwar	VL Light trap, WGPSB-2 powder and seed distribution and VL Polytunnel demonstration
August 5, 2020	Darim	Nainital	Interaction meeting with farmers
October 15, 2020	Lakhani	Bageshwar	Demonstration of VL Metallic Plough, VL Line maker and conducted *Mahila Kisan Diwas*
October 29, 2020	Lakhani and Uderkhani	Bageshwar	Selection of fields/sites for polyhouse construction
November 6, 2020	Lakhani	Bageshwar	Demonstration on rat control and cauliflower seedling distribution
November 18, 2020	Jakhari	Uttarakashi	Interaction with farmers and distribution of farm tools and seeds
November 27, 2020	Lakhani	Bageshwar	Selection of fields/sites for polyhouse construction and supervision of work
December 19, 2020	Lakhani and Maulidhar	Bageshwar	Selection of fields/sites for polyhouse construction and taking over and handing over polyhouses

Krishak Goshti-cum-on-farm training

A *Krishak Goshti*-cum-on-farm training was organized in village Kabhari block Dhaula Devi of District Almora under the Schedule Cast Sub-Plan (SCSP) programme of Institute on January 15, 2020. The farmers were given live demonstrations on Vivek Millet Thresher-cum-Pearler, VL Light Trap & *Bacillus cereus* WGPSB-2 and small farm tools kit.



Krishak Goshthi-cum-on-farm training at Kabhari (Almora) under SCSP programme

The farmers were made aware about the vegetable cultivation, insect and pest management, polytank construction, etc. by the experts. The queries of the farmers were also answered by the experts.

Farmer-Scientist-Press Meet on Protection of Crops from Wild Animals

A Farmer-Scientist-Press Meet on protection of crops from wild animals was organized on February 11, 2020 at ICAR-VPKAS Almora. The objective of the meet was to demonstrate the use of agri canon gun and bioacoustic system for the protection of crops from wild animals especially monkeys, wild boars etc. The demonstration of these instruments was done in the presence of media personnel's, farmers and scientists of the Institute. On the occasion, the questions raised by media personnel and farmers were answered by the experts.

Farmer-scientist-press meet on protection of crops from wild animals on Feberuary 11, 2020 at ICAR-VPKAS, Almora

Participation in online programmes

The SC farmers from different sites attended the online *Kisan Mela* of ICAR-VPKAS, Almora in the Experimental Farm Hawalbagh on October 21, 2020. The farmers attended the online programme "Addressing the farmers and releasing PM Kisan money to farmers" on December 25, 2020 at ICAR-VPKAS, Almora.

Releasing PM Kisan Money to farmers

Water saving through gravity based low-cost sprinkler (Favarra) system in hilly region of Uttarakhand

Water scarcity in hill agriculture is increasing due to climate change, rapid urban expansion, deforestation, forest fires and adverse topographical characteristics. The water availability for agriculture during lean period (March-June) is really a serious challenge to the farmers of hills. In this context efficient utilization of stored rain water during monsoon season and water harvested from spring may play an important role in combating the water scarcity during lean season. Due to adverse undulating topography, water application to small size terrace field in hills is a challenging task. In the present study, gravity based low cost *favarra* system was installed at farmers field to evaluate water saving efficiency compared to traditional irrigation system (syphoning) under the Scheduled Caste Sub-Plan (SCSP) programme of ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand. The result showed that water productivity has increased from 33 to 46% by adopting gravity based low cost sprinkler in comparison to traditional syphon system in hilly region. Therefore, gravity based low cost sprinkler can be used for irrigation on a highly sloping topography.

8. Success Stories

8.1. Low Cost Polytanks for Enhancing Water Productivity in Hills Under *Jal Shakti Abhiyan* Programme of Government of India

The Challenge

Agriculture in hill and mountain region is predominantly rainfed with frequent occurrence of moisture stress. It leads to low productivity of crops, vegetables and orchards, particularly in higher hills. Development of water harvesting structure can be helpful in achieving higher production by mitigating water stress and meeting crop requirement during critical growth stages. The cost of creating huge water resources in hills is very high, thus storage and application losses should be reduced to utilize scarce water efficiently. However, the major part of the rain water received in farmers field of hilly areas goes away unused as runoff. The runoff not only cause loss of water but also washes away top fertile soil. In order to address this problem, institute has adopted Darima village in Nainital district of Uttarakhand under *Jal Shakti Abhiyan* (JSA) programme of Government of India.

The Solution

An attempt was made to construct and renovate tank for rainwater harvesting, subsurface recharge and management of household waste water for reuse. GIS based technology was used not to disturb natural flow line of water. Design also gives protection against excess rains induced breach of bunds. It is the most important step which ensures the maximum surface water that can be intercepted from the catchment area. Keeping the above point in mind, GIS based water delineation technique was used before physical site selection. The output of water delineation technique gives the drainage map of the area with all stream order in site. The site of polytank was selected based on two important parameters i) digging of polytank very close to the drainage line for potential water harvesting ii) at higher elevation than the crop field so that water can flow through gravitational force without any extra energy for irrigation purpose. GIS based site selection incorporates all the parameters *i.e.* topography and drainage line that affect the surface runoff. To provide location specific water conservation measure for collecting runoff or water from spring in undulating topography, a low cost polytank (LCP) structure was made, linking rain water harvesting and need based irrigation in orchard and crops. The construction procedure mainly involve four steps which are (i) site selection, (ii) excavation of pit (iii) treatment of pit, laying of LDPE film (iv) anchoring the LDPE film.

The Application

Popularization of LDPE lined polytanks have opened up possibilities of year-round cultivation of high value vegetables for higher income. The prevailing terrace cultivation in the hill regions provides ample scope for gravity fed micro irrigation system *i.e.* drip and micro sprinkler irrigation. It is recommended that the gravity-fed micro irrigation system must be integrated with the water harvesting system *i.e.* constructed tank at site to effectively and economically utilize the water in agri-horti cum fruit based cultivation in terrace land of the hill farming. Tanks of 7 to 115 m^3 size, trapezoidal shape having slope of 1:1 with 1 to 1.5 meter depth lined with LDPE 200 micron (800-1000 gauge)/250 GSM multilayered cross laminated pond line film were made as per farmer's need. The established water storage structures covered 24.21 ha area and provided irrigation for cultivation of crops. This also helped in utilization of the non-cultivated agricultural and fallow lands for crop and fodder production.

The Impact

A total of 65 (42 newly constructed and 23 renovated) tanks were made at the selected site and geo-tagged for regular monitoring. The average length, breadth and depth of polytanks were 7.1 m, 4.4 m and 1.6 m, respectively. The impact of this work created

Low cost polytanks for enhancing water productivity at Darima village, Nainital under *Jal Shakti Abhiyan* Programme

additional water storage capacity of approximately 3312 cubic meter, which has enhanced the farm water productivity and significantly covered 24.21 ha area under irrigation throughout the year. The farmer's net income increased with the cultivation of vegetable pea, peach, plum and apple from Rs. 39,095/acre to Rs. 76,975/acre *i.e.* an increase of 97% in total income from agriculture. Sixty five farm households were benefitted.

8.2. Farmer participatory Seed Production of Garden Pea at Bail-Parao, Nainital, Uttarakhand

The Challenge

Availability of quality seed of recommended improved vegetable varieties is inadequate in the state. Feasibility and acceptability for large scale seed production at farmer field of newly released varieties are to be tested.

The Solution

In order to tackle the mentioned challenges/issues the varietal demonstration-cum-seed production of newly released varieties of garden pea, *viz.* VL *Sabji Matar* 13 (early maturing variety) & VL *Sabji Matar* 15 (medium maturing variety with field resistance to powdery mildew was carried out during *rabi* 2019-20 by the Institute in Narrottampur (Bail-Parao, Nainital, Uttarakhand) on 2.00 acres area (29.3089ºN, 79.2014 ºE). Mr. Rahul Singh showed his willingness to take up these varieties. The demonstration-cum-seed production plots of VL *Sabji Matar* 13 and VL *Sabji Matar* 15

Deliberation by the Director, ICAR-VPKAS, Almora during the field day

Imparting technical know-how of varieties

Visit to the seed production field

Rouging in the seed production field

were frequently monitored by institute scientists for providing timely technical know-how and for ensuring varietal genetic purity. Farmers' from the village used to participate in scientists farmers' interaction meetings enthusiastically to know about the recently developed garden pea varieties and seed production-related technical know-how. A field day was organized at Narrottampur village on January 10, 2020, which was attended by around 50 farmers from Bailparao.

The application

This approach has been found very much useful in the dissemination of new varieties among farmers and at the same time, more farmers can be trained in seed production at massive scale. This strategy not only provide the quality seed in a large quantity but also strengthen the process of bringing farmers under seed production programme with better income option, and as an effective capacity-building strategy concerning vegetable seed industries.

The Impact

After notification, in the very first year of both these varieties, 6.155 q seed was harvested and supplied by the farmer to the Institute. The variety-wise details of seed received are mentioned below:

TL Seed procured from Mr. Rahul Singh during 2019-20

Garden pea variety	Seed received (q)
VL *Sabji Matar* 13	4.695
VL *Sabji Matar* 15	1.460

Mr. Rahul Singh, the farmer who is directly associated with the seed production of both varieties, expressed his satisfaction over the performance of these varieties. The income gained by seed-producing and by direct procurement of seed by the Institute (at Institute approved rate Rs. 120/kg of quality seed) to the farmer is 0.74 lakhs rupees form 2 acre area.

Mr. Rahul Singh shared his experience about these varieties with fellow farmers. Farmers from his village also appreciated the performance of these varieties and showed their willingness to take-up these varieties for cultivation as well as seed production in coming *rabi* season.

8.3. Farmers Participatory Rice Seed Production: A Profitable Venture for Hill Farmers of Uttarakhand

The Challenge

Rice is a major *kharif* crop of Uttarakhand, grown over a wide altitudinal range (250 to 2500 m amsl) and in large acreages. Although, rice is a dominant crop of food and cropping systems of hilly region still the hill farmers are not reaping profit from rice cultivation mainly due to unavailability of quality seed of improved varieties. Therefore, farmers of the region are forced to grow farmer saved seeds of landraces, old and obsolete varieties which are generally poor yielding. The predominance of local varieties is also reflected by poor seed replacement rate (5-15%) of rice in Uttarakhand. The situation of poor seed availability of recommended varieties in the region necessitates the efforts for ensuring the access of farmers to quality seed.

The Solution

Seed is the carrier of technology and it is the most important, less expensive, very crucial, critical, basic and vital input for attaining sustained growth in crop production. Good quality seed acts as a catalyst for realizing the potential of all other inputs to be cost effective. The use of quality seeds alone could increase 20-25% of the yield and under optimum management; the increase may go upto 45%. Farmers need to have access to good quality seeds of improved variety at the right time, at the right place and at a reasonable price for enhancing and sustaining the rice productivity.

The Application

Recently released improved variety of irrigated rice, *viz*. VL *Dhan* 68 from ICAR-VPKAS, Almora was demonstrated at the farmer's field in 20 *nali* (0.4 ha) each by Shri Lakshman Singh at Basulishera and Shri Syam Singh at Raulshera and 10 *Nali* (0.2 ha) by Sri Hari Singh Bora at Dhaunigarh for TL seed production along with suitable crop production and protection packages. The technical knowhow and inputs were provided at all the stages of crop i.e. nursery raising, plant to plant distance, rouging at different stages of crop, weed management, plant protection measures. The yield potential of VL *Dhan* 68 is 45-50 q/ha under standard agronomic practices. It matures in 125-130 days and has long bold grain. It is resistant to leaf and neck blast, the most important disease of rice in the hills.

The Impact

These farmers were able to harvest 46-48 quintals grain yield per hectare compared to 34-35 quintals per hectare earlier (increased 33.65% over farmer's practice). The average net return was Rs.31,910.0 per hectare with B:C ratio 0.76 of improved variety.

The seed of VL *Dhan* 68 was purchased back from the farmers at Rs. 2,200/q institute rate. The successful cultivation of rice variety, VL *Dhan* 68 has increased production and income of farmers. Other farmers of that village and nearby villages also interacted with them and shown interest in cultivating VL *Dhan* 68.

8.4. From Passion to Profession - A Success Story of a Mushroom Woman Farmer in Uttarakhand Hills

The Challenge

Mushroom is an eco-friendly cash crop, which is cultivated on agricultural wastes and residues and provides ample opportunities for employment and extra-income to the farmers. It is cultivated indoors utilizing the waste-land and the spent compost or the substrate left over after a crop of mushroom is harvested, is excellent organic manure which helps to improve the fertility of the soil or can be used to improve the nutritive value of the fodder fed to the cattle. Mushroom farming as the key activity for the farmers has the potential to solve the problems which the farmers of India are currently facing. Also, the farmer's family will be getting a nutritious and delicious food like mushrooms at their door-step, which would help to improve the nutritional security of rural India.

The Solution

In the year 2016, Mrs. Preeti Bhandari came in contact with ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan. Before that she attended 05 days training programme on "Mushroom Cultivation" at Jeolikot. She was determined to take mushroom cultivation as part time profession. Later on, she started receiving technical guidance from ICAR-VPKAS and engaged in mushroom cultivation since 2016. She started producing button (*Agaricus bisporus*) mushroom with meagre amount of 02 q pasteurized compost. She was able to harvest 45 kg of fresh button mushroom out of it. 35 kg was sold as fresh by her @ Rs. 150.0 per kg and remaining 10 kg was used to prepare pickle. She sold pickles @ Rs. 400.0 per kg. This way she earned Rs. 9250.0 in 03 months' time duration. She became satisfied with the income which was generated from her part time profession. She narrated that earlier there were very few customers of her mushroom products even at the cost of Rs. 80 per kg. Though the enterprise used to meet out only maintenance cost and generate not much profit, but still she did not lose her heart and continued the cultivation every year. But over a

period of time the awareness among common people in hills regarding the nutritional and medicinal aspects of the mushrooms is developed through several sensitization programmes organized by the Institute at farmer's site. Now she is selling one kg of mushroom for Rs. 180.Besides, she also started to make mushroom pickle which is having a good demand in and around the locality.

Impact/ Success Story

A clear growth in mushroom production over the years was observed. During the year 2016-17, a total of Rs. 9250.00 was generated using 02 Qtl of compost which was increased to Rs. 4,46,100.00 in year 2019-20 using 130 q of compost.

Table Details of mushroom production and revenue generation during years

Year	Total Compost used (q)	Total harvest (kg)	Revenue generation (Rs.)
2016-17	02	45	9,250.00
2017-18	10	270	40,500.00
2018-19	20	450	67,500.00
2019-20	130	2400	4,46,100.00

Mrs. Bhandari has started delivering lectures on mushroom production in nearby areas/ NGOs and has become mushroom trainer for the unemployed youths. She has been awarded by the District Magistrate, Almora for her work in promotion of mushroom farming amongst hill youths and "Teelu Rauteli Award" by Hon'ble Chief Minister, Uttarakhand for 2019-20.

Cost

Cost-benefit status of button mushroom and its economics at farmer's field is given as under:

Mushroom species	Materials	Cost (Rs.)	Yield	Market rate (Rs.)	C:B ratio
Button mushroom	Pasteurized compost (01 t) along with spawn and casing soil Transportation Polythene bags (100 Nos.) Chemicals	4200.00 4,000.00 400.00 200.00	200 kg	150.00	**1:3.4**
	Total cost (Rs.)	**8800.00**		**30,000.00**	

Way forward

Although the button mushroom production resulted in increased revenue generation by the farmer, however, there is a need to look into the adoption of different edible and medicinal mushrooms species in order to cultivate mushrooms round the year. Keeping in view the short life span of fresh mushrooms, value addition of mushrooms might be an alternate option for mushroom growers to sale their produce at higher rate in the market either in the form of mushroom pickle, mushroom powder or dried mushroom. In order to curtail migration in search of employment from rural hilly areas to urban cities, mushroom might play a key role in engagement of village youths.

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Prepration of compost bag for mushroom production by trainee farmers

9. Farmers' Feedback

I have been cultivating local *Bhat* and soybean from long ago but cultivation of local cultivars of soybean/*Bhat* was not very profitable due to low yield, prone to trailing, lodging and susceptibility to insect & disease. During 2019, I came in contact with ICAR-VPKAS during front line demonstrations of improved varieties at my village. By adopting improved varieties (VL *Soya* 89 and VL *Bhat* 201) with recommended production and protection technologies, I had achieved 35-40% higher production than local cultivars.

Shri. Devendra S.Bisht, village-Patia, Almora

I have been associated with ICAR-VPKAS Almora Uttarakhand for the last 3 years. I thank the Institute for its commendable work in providing good information and good quality hybrid seeds to the farmers for agriculture and solutions to agricultural problems through tools, modern farming, agricultural training and digital technology which are provided from time to time. The best part is the simple and direct connectivity of government institutions with farmers.

Shri. Sohan Singh, village Parsari, Chamoli

I have been associated with your institute for the last two years. I have been getting agricultural machineries and seeds of *rabi* and *kharif* seasons from time to time and also training on improved farming which makes it easier for me to do improved farming. I thank the Institute and hope they continue to provide schemes related information for guiding the tribal farmers.

Shri. Devendra Singh village Parsari, Chamoli

I have been associated with ICAR-VPKAS for the last 6-7 years. The institute has given us seeds like cabbage, cauliflower, coriander, peas, rajmash, rye, garlic, onion, etc. in every season. Organic pesticides were also provided. I request them to continue to cooperate with us in this way so that our livelihood can be further improved.

Shri. Anand Singh village Merag, Chamoli

I came in contact with ICAR-VPKAS during 2018-19 when they provided us maize variety VMH 45 which was found very suitable for the soil of village Jalukiemam. I would like to continue growing this improved maize variety with technical guidance of scientist of ICAR-VPKAS.

Shri. Hangnul village Jalukiekam, Nagaland

10. Trainings & Capacity Building

Training of Institute Personnel

The following institute personnel were deputed for different HRD programmes as per Annual Training Plan (ATP) during 2020 (Table 10.1).

Table 10.1. Details of trainings undergone by institute staff

Duration	Participant	Topic	Venue
Scientific Staff			
International Trainings			
February 3 to November 28, 2020	Dr. Navin Chander Gahtyari	Wheat breeding and pathology training targeted for wheat blast.	CIMMYT, Mexico
September 28 to October 2, 2020	Dr. Jitendra Kumar	Agriculture 4.0: Precision and automated Ag technologies	Online organized by CAAST, MPKV, Rahuri, NAHEP, ICAR, New Delhi
October 6-7, 2020	Dr. Rahul Dev	DUS data management/ automation/ image analysis in crops	Webinar cum training organized by Min. of Agric. & FW, GOI and Federal Ministry of Food & Agriculture, Germany
National Trainings			
February 10-14, 2020	Dr. Renu Jethi	Climate change challenges response	Centre for Disaster Management, Lal Bahadur Shastri National Academy of Administration (LBSNAA), Mussoorie
April 21-29, 2020	Dr. Jitendra Kumar	Protected cultivation technologies for climate smart agriculture	Online organized by CAAST, MPKV, Rahuri, NAHEP, ICAR, New Delhi
May 08, 2020	Dr. Pankaj Kumar Mishra	Training management information system (TMIS) for HRD nodal officers of ICAR	Online organized by HRM, ICAR, New Delhi
June 15-23, 2020	Dr. Jitendra Kumar	Drip irrigation and fertigation management	Online organized by CAAST-SNRM, PAU, Ludhiana
June 29 to July 3, 2020	Dr. Amit Paschapur	Pest risk analyses	Online organized by NIPHM, Hyderabad
June 29 to July 3, 2020	Dr. Shyam Nath	Ergonomics design guidelines for agricultural tools and equipment	Online organized by ICAR-CIAE, Bhopal
June 29-July 3, 2020	Dr. Jitendra Kumar	Advanced agrometeorological techniques for climate smart agriculture	Online organized by CAAST, MPKV, Rahuri, NAHEP, ICAR, New Delhi
July 21-22, 2020	Dr. Devender Sharma	Integrated pest management for maize crop with special reference to fall armyworm	Online organized by FAO, India
September 5-7, 2020	Dr. Pankaj Kumar Mishra	Learning statistics and data analysis using MS Excel	Online by Simple Statistics Solution and Training Provider (SSSTP), Tirunelveli, Tamil Nadu

September 12-28, 2020	Dr Sher Singh	Intellectual property rights in agricultural research & education in India.	Virtual workshop-cum-training organized by NAHEP and IP & TM, ICAR, New Delhi
September 14-19, 2020	Drs. A.R.N.S. Subbanna & Jeevan B	Advanced bioinformatics tools and its applications in agriculture.	Online organized by ICAR-NAARM, Hyderabad
November 9-17, 2020	Drs. Brij Mohan Pandey, Devender Sharma and Asha Kumari	Analysis of experimental data using SAS	Online organized by ICAR-NAARM
December 14-18, 2020	Dr. Kushagar Joshi	Management development program for women in development sector	Webinar cum training organized by MANAGE, Hyderabad
December 14-18, 2020	Dr. Renu Jethi	Internet of things (IoT) for academicians, scientists & technologists working in government sector	Online organized by Staff College of India, Hyderabad
December 15-19, 2020	Ms. Asha Kumari	Integrating gender concerns in agricultural research and extension for improving livelihood of farmwomen	E-training programme organized by ICAR-CIWA, Bhubaneswar
Technical Staff			
June 29 to July 3, 2020	Shri .Jaiprakash Gupta	Pest risk analysis	Online organized by NIPHM, Hyderabad
August 24- 28, 2020	Shri. Dinesh Chandra Mishra & Jaiprakash Gupta	Rodent pest management	Online organized by NIPHM, Hyderabad
July 1-31, 2020	Drs. Pankaj Nautiyal & Gaurav Papnai	Designing e-learning content	Online organized by ICAR-NAARM, Hyderabad
September 7-11, 2020	Dr. Kamal Kumar Pande	Post harvest management and storage techniques	Online organized by NIPHM, Hyderabad
December 2 - 4, 2020	Shri. Harish Chandra Joshi	Quarantine pathogens- detection and identification	Online organized by NIPHM, Hyderabad
Administrative Staff			
July 23, 2020	Smt. Radhika Arya & Shri Nandan Singh Rajwar	E-Office training	Online training organized by ISTM, New Delhi
November 23-27, 2020	Mr. Sunder Ram	Establishment rules-2	Online training programme organized by ISTM, New Delhi
December 14-18, 2020	Smt. Radhika Arya	Management development program for women in development sector	Online webinar training programme organized by MANAGE, Hyderabad

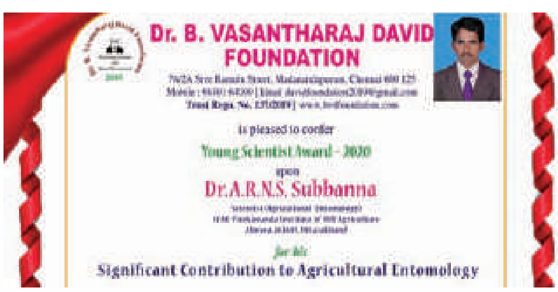
11. Awards & Recognitions

- Dr. Lakshmi Kant, Principal Scientist & Head CID elected NAAS Fellow 2020.

- Dr. J. Stanley, Scientist (Entomology) received NAAS Associate 2020.

- Dr. Vijay Singh Meena, Scientist (Soil Science) received NAAS Associate 2020.

- Dr ARNS Subbanna received Young Scientist Award-2020 by Dr. B. Vasantharaj David Foundation, Chennai.



- Dr. K. K. Mishra, Principal Scientist (Plant Pathology) received Reviewer Excellence Award (2020) by Agricultural Research Communication Centre, Karnal, Haryana.
- KVK, Kafligair, Bageshwar was recipient of Second Best KVK Award 2019 during Zonal Workshop of KVKs of Zone 1 on July 7, 2020.

- Dr. J.P. Aditya, Sr. Scientist (Plant Breeding) received Dr. Boshi Sen Memorial Award for "Outstanding Scientific Staff" for 2019-20.

- Smt Nidhi Singh, Program Assistant (Lab Tech.) receibved Directors Appreciation letter for 2019-20.

12. Linkages & Collaborations

The Institute has effective linkage and collaboration with the following organizations:

12.1. Local Institution in the Area

- G.B. Pant National Institute of Himalayan Environment & Sustainable Development (GBPNIHESD), Kosi-Katarmal, Almora, Uttarakhand
- Defence Institute of Bio-energy Research (DIBER), Haldwani, Uttarakhand
- Kumaun University, SSJ Campus, Almora, Uttarakhand

12.2. National Institutes and Agricultural Universities

- ICAR-Indian Agricultural Research Institute, New Delhi
- ICAR-National Rice Research Institute, Cuttack, Odisha
- ICAR- Indian Institute of Wheat & Barley Research, Karnal, Haryana
- ICAR-Indian Institute of Rice Research, Hyderabad, Telangana
- ICAR-Indian Institute of Millet Research, Hyderabad, Telangana
- ICAR-Indian Institute of Maize Research, Ludhiana, Punjab
- ICAR- Indian Institute of Pulses Research, Kanpur, Uttar Pradesh
- ICAR-Indian Institute of Soil and Water Conservation, Dehradun, Uttarakhand
- ICAR-Central Institute of Temperate Horticulture, RS, Mukteshwar, Uttarakhand
- ICAR-National Bureau of Agriculturally Important Microorganism, Mau, Uttar Pradesh
- ICAR-National Centre for Integrated Pest Management, New Delhi
- ICAR-Indian Institute of Seed Science, Mau, U.P.
- ICAR-Central Institute of Post Harvest Engineering and Technology, Ludhiana
- ICAR-Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh
- ICAR-Central Research Institute for Dryland Agriculture, Hyderabad, Telangana
- ICAR-Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh
- ICAR-North Eastern Hill Complex, Barapani, Megalaya
- G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand
- CSK-Himachal Pradesh Krishi Vishwa Vidyalaya, Palampur, Himachal Pradesh
- Dr. Y.S. Parmar University of Horticulture and Forestry, Solan,Himachal Pradesh
- Sher-e-Kashmir University of Agriculture & Technology, Srinagar, J&K

12.3. International Organizations

- IRRI, Manila, Philippines
- CIMMYT, Mexico
- ICRISAT, Hyderabad, India
- ICARDA, Moracco
- Bioversity International
- University of Cologne, Germany

12.4. Extension & Development Agencies

- State Department of Agriculture, Uttarakhand
- Indian Farmers Fertilizer Cooperative
- National Agricultural Bank for Rural Development
- Mahindra & Mahindra Subh Labh Services
- Private Agencies
- Watershed Management Directorate, Uttarakhand
- NGOs [Syahi Devi Vikas Samiti, Almora; Himalayan Environmental Studies & Conservation Organization (HESCO), Dehradun; Himmotthan, Dehradun etc.]
- Food Corporation of India (FCI)
- Department of Agriculture and Cooperation
- Departments of North Eastern Hill States

13. Important Committees of the Institute

13-1- jktHkk"kk dk;kUo;u lfefr

- डॉ0 अरूनव पट्टनायक– निदेशक, अध्यक्ष (फरवरी 17, 2020 तक)
- डॉ0 लक्ष्मी कान्त– निदेशक, अध्यक्ष (फरवरी 18, 2020 से)
- डॉ0 रेनू जेठी– वैज्ञानिक, सदस्य
- प्रशासनिक अधिकारी– सदस्य (जून 30, 2020 तक)
- वरिष्ठ प्रशासनिक अधिकारी– सदस्य (अगस्त 14, 2020 से)
- वित्त एवं लेखा अधिकारी– सदस्य
- श्रीमती रेनू सनवाल– तकनीकी अधिकारी, सदस्य
- ललित मोहन तिवारी– सहायक प्रशासनिक अधिकारी, सदस्य सचिव

13.2. Institute Joint Council (IJC)

(Upto June 20, 2020)

Chairman – Director, Dr. A. Pattanayak

Members (Official Side)– Drs. B.M. Pandey, Pr. Scientist; Renu Jethi, Sr. Scientist; Mrs. Radhika Arya, Assistant Administrative Officer

Members (Staff Side) – Mr. Vishnu Dutt Pandey, LDC; Mr. Nandan Singh Rajwar; Mr. Manoj Kumar; Mr. N.K. Pathak; Mr. P.S. Nikhurpa and Mr. M.C. Bhatt

(*w.e.f.* September 07, 2020)

Chairman – Director, Dr. Lakshmi Kant

Members (Official Side) – Drs. N.K. Hedau, Pr. Scientist; Kushagra Joshi, Scientist; Shri. R.S. Negi, Senior Administrative Officer; Shri. B.C. Pandey, Finance & Accounts Officer; Mrs. Radhika Arya, Assistant Administrative Officer; Shri. Lalit Mohan Tiwari, Assistant Administrative Officer

Members (Staff Side) – Mr. Sachin Kumar Pandey, UDC; Shri Vishnu Dutt Pandey, LDC; Mr. Medni Pratap Singh, Farm Manager; Mr. Neeraj Kumar Pandey, Technical Assistant; Mr. Mohan Chandra Bhatt, SSS; Mr. Bhagwan Ballabh Tiwari, SSS

13.3. Research Advisory Committee (RAC)

Chairman – Dr. K.R. Dhiman, Ex. Vice Chancellor, Dr. Y.S. Parmar University & Horticulture & Forestry, Nauni, Solan (H.P)

Members – Assistant Director General (FFC), Indian Council of Agricultural Research, Krishi Bhawan, New Delhi; Dr. J.P. Singh, Professor (Horticulture), GBPUA&T, Pantnagar (Uttarakhand); Dr. J.C. Rana, National Coordinator, UN Environment-GEF Project Bioversity International-India Office, New Delhi; Dr. Arun Kumar Sharma, Ex. Director ICAR-NBAIM, Mau, U.P.; Dr. B.S. Mahapatra, Professor (Agronomy), GBPUA&T, Pantnagar (Uttarakhand); Dr. K.K. Satpathy, Ex. Director, ICAR-NINFET, Kolkata; Dr. H.C. Bhattacharyya, Director Extension, Assam Agricultural University, Jorhat, Assam; Dr. A. Pattanayak, Director, ICAR-VPKAS, Almora, Uttarakhand; Shri. Nagendra Kumar, farmer member; Shri Sushil Tyagi, farmer member

Member Secretary – Dr. J.K. Bisht, Pr. Scientist & In-Charge (PME Cell)

13.4. Institute Management Committee (IMC)

Chairman – Director, ICAR-VPKAS, Almora

Members – Assistant Director General (Seeds), ICAR, New Delhi; Joint Director of Agriculture, Govt. of Uttarakhand; Director of Agriculture, Govt. of Jammu & Kashmir; Director, Directorate of Extension Education, GBPUA&T, Pantnagar; Dr Rajnarayan, Station In-Charge, ICAR-IVRI, Mukteshwar; Dr. Mamta Arya, Office In-Charge, NBPGR Regional Station, Bhowali; Dr. J.K. Bisht, ICAR-VPKAS, Almora; Dr. Lakshmi Kant, ICAR-VPKAS, Almora; The Finance & Accounts Officer, IVRI, Bareilly; Shri Nagendra Kumar, Non-Official/ farmer member; Shri Sushil Tyagi, Non-Official/ farmer member

Member Secretary– Sr. Administrative Officer/ Administrative Officer

13.5. Institute Research Council (IRC)

Chairman – Director

Members – All the Scientists of ICAR- VPKAS, Almora

Member Secretary – In-charge (PME Cell)

13.6. Institute Technology Management Committee (ITMC)

Chairman – Director

Members – Head, Crop Improvement Division; Head, Crop Production Division; Dr. Arun Kishore, CITH RS, Mukteshwar; Dr. J.K. Bisht, Pr. Scientist

Member Secretary – Dr. Lakshmi Kant, Pr. Scientist & Head, CID

13.7. Institute Technology Management Unit (ITMU)

Chairman – Dr. Lakshmi Kant, Pr. Scientist & Head, Crop Improvement Division

Members – Drs. J.K. Bisht, Pr. Scientist & Head, Crop Production Division; R.K. Khulbe, Pr. Scientist; Sher Singh, Pr. Scientist; Finance and Accounts Officer

13.8. Study Leave Committee (SLC)

Chairman –Dr. J.K. Bisht, Head, CPD

Member – Drs. P.K. Mishra, Pr. Scientist, N.K. Hedau, Pr. Scientist

Member Secretary –Mr. A.K. Joshi, Administrative Officer (upto 30.06.2020), Mrs. Radhika Arya, Asstt. Administrative Officer (w.e.f July 1, 2020 to August 30, 2020), Mr. R.S. Negi, Sr. Administrative Officer (*w.e.f.* September 1, 2020)

13.9. PERMISNET/PIMSICAR/HYPM

Nodal Officer– Dr. Renu Jethi, Sr. Scientist

13.10. Committee for Monitoring of Field Experiments

Chairman – Director, ICAR-VPKAS, Almora

Members – All the Scientists of ICAR-VPKAS, Almora

Member-Secretary - In-charge/Coordinator, PME Cell

13.11. Vigilance Cell (VC)

Dr. K.K. Mishra, Pr. Scientist (upto Sept. 1, 2020)

Dr. J.K. Bisht, Pr. Scientist (*w.e.f.* September 2, 2020)

13.12. Grievance Cell (GC)

Chairman - Dr. Lakshmi Kant, Pr. Scientist & Head, CID

Members - Dr. Anuradha Bhartiya, Scientist; Farm Coordinator; Administrative Officer; Finance & Accounts Officer

13.13. Women Cell (WC)

Chairman - Dr. Renu Jethi, Sr. Scientist

Members - Mrs. Radhika Arya, Assistant Administrative Officer; Mrs. Renu Sanwal, Technical Officer

Member Secretary - Ms. Usha Birdi, Assistant

13.14. Internal Complaint Committee (ICC)

Chairman - Dr. Kushagra Joshi, Scientist

Members - Dr. Sher Singh, Pr. Scientist, Mrs. Renu Sanwal, T.O.; Ms. Usha Birdi, Assistant; Mrs. Lata Harbola, Programme Coordinator, Chirag

13.15. Purchase Advisory Committee (PAC)

(Upto April 23, 2020)

Chairman– Dr. Lakshmi Kant, Pr. Scientist & Head, CID

Members – Drs. R.K. Khulbe, Pr. Scientist; ARNS Subbanna, Scientist; Jitendra Kumar, Scientist; Finance & Accounts Officer

Member Secretary - Administrative Officer (Purchase & Store)

(*w.e.f.* April 24, 2020)

Chairman– Dr. J.K. Bisht, Pr. Scientist & Head

Members – Drs. P.K. Mishra, Pr. Scientist; J.P. Aditya, Sr. Scientist; Rakesh Bhowmick, Scientist, Kushagra Joshi, Scientist; Finance & Accounts Officer

Member Secretary–In-Charge (Purchase & Store)

13.16. Standing Purchase Committee (SPC)

(upto April 23, 2020)

Chairman– Dr. J.K. Bisht, Pr. Scientist & Head, CPD

Members – Er. Shyam Nath, Scientist; Dr. Manoj Parihar, Scientist; Shri. Sanjay Kumar Arya, ACTO

Member Secretary -Administrative Officer (Purchase & Store)

(w.e.f. April 24, 2020)

Chairman– Dr. S.C. Panday, Pr. Scientist

Members – Drs. Sher Singh, Pr. Scientist; R.P. Yadav, Scientist; Jitendra Kumar, Scientist ; Rakesh Bhowmick, Scientist ; Finance & Accounts Officer
Member Secretary - In-Charge (Purchase & Store)

13.17. Technical Vetting/ Screening Committee (TVC)

(Upto April 23, 2020)
Chairman– Dr. P.K. Mishra, Pr. Scientist
Members – Drs. B.M. Pandey, Pr. Scientist; Sher Singh, Pr. Scientist; Ram Prakash Yadav, Scientist; Shri Sanjay Kumar Arya, ACTO
Member Secretary -Administrative Officer (Purchase & Store)
(w.e.f. April 24, 2020)
Chairman– Dr. B.M. Pandey, Pr. Scientist
Members – Drs. N.K. Hedau, Pr. Scientist; Renu Jethi, Sr. Scientist; Ramesh Singh Pal, Scientist; Jitendra Kumar, Scientist
Member Secretary - In-Charge (Purchase &Store)

13.18. Institute Bio-safety Committee (IBSC)

Chairman – Director, ICAR-VPKAS, Almora
Members – Dr. R.C. Sundriyal, Scientist (G), GBPHED, Kosi Katarmal (DBT nominee upto September 2020), Dr. Indra D. Bhatt, Scientist (G), GBPHED, Kosi Katarmal (DBT nominee *w.e.f.,* September 26, 2020); Dr. Ila Bisht, Professor & Head, Kumaon University, SSJ Campus, Almora (Outside Expert); Dr. A.S. Gusain, Medical Officer, Almora (Bio-safety Officer); Drs. K.K. Mishra, Pr. Scientist; Rajashekara, H., Scientist and Mr. Rakesh Bhowmick, Scientist (Internal experts)
Member Secretary- Dr. P.K. Mishra, Pr. Scientist

13.19. House Allotment Committee (HAC)

Chairman– Dr. J.K. Bisht, Pr. Scientist and Head, CPD
Members – Dr. B.M Pandey, Pr. Scientist; Er. D.C. Mishra, ACTO
Member Secretary –Administrative Officer

13.20. Public Information Cell (PIC)

Public Information Officer – Dr. J.K. Bisht, Pr. Scientist & Head; Dr. N.K. Hedau, Pr. Scientist;, Shri. A.K. Joshi, Administrative Officer (upto June 30, 2020); Shri. R.S. Negi, Sr. Administrative Officer (*w.e.f.* August 14, 2020)

13.21. Public Information Officer (KVK, Chinyalisaur and Bageshwar):

Program Coordinator, KVK, Bageshwar
Program Coordinator, KVK, Uttarkashi

13.22. Strengthening Statistical Computing for NARS

Nodal Officer- Dr. Kushagra Joshi, Scientist

13.23. mKisan

Nodal Officer – Dr. Kushagra Joshi, Scientist

13.24. Institute Swachchhta Abhiyan Committee (ISAC)

Chairman - Dr. K.K. Mishra, Pr. Scientist
Member – Dr. Kushagra Joshi, Scientist and Administrative Officer (upto June 30, 2020); Mr. Lalit Mohan Tewari (*w.e.f.* July 01, 2020)

13.25. Human Resource Development (HRD)

Nodal Offcier – Dr. P.K. Mishra, Pr. Scientist

13.26. Research Data Management (RDM)

Nodal Offcier – Dr. P.K. Mishra, Pr. Scientist
Co-Nodal Offcier- Dr. Renu Jethi, Sr. Scientist
Members- Drs. Sher Singh, Pr. Scientist and K.K. Mishra, Pr. Scientist

13.27. Institute Germplasm Identification Committee (IGIC)

Chairman- Dr. L. Kant, Pr. Scientist & Head, CID
Member- Drs. P.K. Mishra, Pr. Scientist; K.K. Mishra, Pr. Scientist and R.K. Khulbe, Pr. Scientist

13.28. Innovation Cell (IC)

Nodal Officer- Dr. P.K. Mishra, Pr. Scientist
Members- Dr. Renu Jethi, Sr. Scientist; Dr. ARNS Subbanna, Dr. D.C. Joshi; Sr. Administrative Officer

13.29. Mera Gaon Mera Gaurav (MGMG)

Nodal Officer- Dr. Kushagra Joshi, Scientist (upto Oct. 05, 2020); Dr. Om Vir Singh, Pr. Scientist (*w.e.f.* Oct. 06, 2020)

13.30. Social Media Committee

Chairperson- Dr. B. M. Pandey, Pr. Scientist
Members- Dr. Renu Jethi, Sr. Scientist and Dr. Kushagra Joshi. Scientist

14. List of Publications

14.1. Scientific Paper Published in Peer Reviewed Journals/ Proceedings

Research Papers	NAAS Rating	Krishi Portal ID
Mondal, T., Yadav, R.P., Meena, V.S., Choudhary, M., Nath, S., Bisht, J.K., Mishra, P.K., Arya, S.K. and Pattanayak, A. (2020). Biomass yield and nutrient content of dual-purpose wheat in the fruit based cropping system in the North Western mid-Himalaya ecosystem, India. *Field Crops Research*, 247: 1-9.	9.87	http://krishi.icar.gov.in/jspui/handle/123456789/29979
Choudhary, M., Panday, S.C., Meena, V.S., Singh, S., Yadav, R.P., Pattanayak, A., Mahanta, D., Bisht, J.K. and Stanley, J. (2020). Long-term tillage and irrigation management practices: Strategies to enhance crop and water productivity under rice-wheat rotation of Indian mid-Himalayan Region. *Agricultural Water Management*, 232 106067 DOI.org/10.1016/j.agwat.2020.106067	9.54	http://krishi.icar.gov.in/jspui/handle/123456789/34475
Choudhary, M., Meena, V.S., Panday, S.C., Mondal, T., Yadav, R.P., Mishra, P.K., Bisht, J.K. and Pattanayak, A. (2020). Long-term effects of organic manure and inorganic fertilization on biological soil quality indicators of soybean-wheat rotation in the Indian mid-Himalaya. *Applied Soil Ecology*, 157 103754. doi.org/10.1016/j.apsoil.2020.103754	9.45	http://krishi.icar.gov.in/jspui/handle/123456789/42928
Parihar, M., Rakshit, A., Rana, K., Meena, R.P. and Joshi, D.C. (2020). A consortium of arbuscular mycorrizal fungi improves nutrient uptake, biochemical response, nodulation and growth of the pea (*Pisum sativum* L.) under salt stress. *Rhizosphere*, 15: 100235.	8.079	http://krishi.icar.gov.in/jspui/handle/123456789/43018
Parihar, M., Rakshit, A., Meena, V.S., Gupta, V.K., Rana, K., Choudhary, M., Tiwari, G., Mishra, P.K., Pattanayak, A., Bisht, J.K. and Jatav, S.S. (2020). The potential of arbuscular mycorrhizal fungi in C cycling: a review. *Archives of Microbiology*, 202: 1581-1596.	7.884	http://krishi.icar.gov.in/jspui/handle/123456789/42980
Aeron, A., Khare, E., Jha, C. K., Meena, V. S., Aziz, S. M. A., Islam, M. T., Kim, K., Meena, S.K., Pattanayak, A., Rajashekara, H., Dubey, R.C., Mourya, B.R., Maheshwari, D.K., Saraf, M., Choudhary, M., Verma, R., Meena, H.N., Subbanna, A.R.N.S., Parihar, M., Shukla, S., Muthusamy, G., Bana, R.S., Bajpai, V.K., Han, Y.K., Rahman, M., Kumar, D., Singh, N.P. and Meena, R.K. (2020). Revisiting the plant growth-promoting rhizobacteria: lessons from the past and objectives for the future. *Archives of Microbiology*, 202(4): 665-676.	7.64	http://krishi.icar.gov.in/ jspui/handle/123456789/45329
Bhartiya, A., Aditya, J.P., Pal, R.S., Chandra, N., Kant, L. and Pattanayak, A. (2020). Bhat (Black Soybean): A traditional legume with high nutritional and nutraceutical properties from NW Himalayan region of India. *Indian Journal of Traditional Knowledge*, 19(2): 307-319.	6.92	http://krishi.icar.gov.in/jspui/handle/123456789/47303
Kumar, U., Sahoo, B., Chatterjee, C. and Raghuwanshi, N.S. (2020). Evaluation of Simplified Surface Energy Balance Index (S-SEBI) method for estimating actual evapotranspiration in Kagnsabati reservoir command using Landsat-8 imagery. *Journal of the Indian Society of Remote Sensing*, DOI: 10.1007/s12524-020-01166-9.	6.87	http://krishi.icar.gov.in/ jspui/handle/123456789/45089

Jeevan, B., Gogoi, R., Sharma, D., Manjunatha, C., Rajashekhra, H., Mishra, K.K. and Mallikarjuna, M.G. (2020). Genetic analysis of maydis leaf blight resistance in subtropical maize (*Zea mays* L.) germplasm. *Journal of Genetics,* 99: 89.	6.83	http://krishi.icar.gov.in/jspui/handle/123456789/45087
Parihar, M., Rakshit, A., Rana, K., Tiwari, G. and Jatav, S.S. (2020). The Effect of arbuscular mycorrhizal fungi inoculation in mitigating salt stress of pea (*Pisum Sativum* L.). *Communications in Soil Science and Plant Analysis*, 51(11): 1545-1559.	6.76	http://krishi.icar.gov.in/jspui/handle/123456789/43019
Sharma, D., Jaiswal, J.P., Gahtyari, N.C., Chauhan, A., Chhabra, R., Saripalli, G. and Singh, N.K. (2020). Population structure, association analysis and identification of candidate genes for terminal heat stress relevant traits in bread wheat (*Triticum aestivum* L. em Thell). *Plant Genetic Resources*, 18(3):168-178	6.72	http://krishi.icar.gov.in/jspui/handle/123456789/45084
Tuti, M.D., Pal, R.S., Mahanta, Dibakar, Pandey, B.M. and Bisht, J.K. (2020). Chemical and biological activities under vegetable intensive colocasia-based cropping system in Indian Sub-Himalayas, *Communications in Soil Science and Plant Analysis,* 51(7): 948-962.	6.69	-
Panday, S.C., Kumar A., Meena, V.S., Joshi, K., Stanley, M.J. and Pattanayak, A. (2020). Standardized precipitation index (SPI) for drought severity assessment of Almora, Uttarakhand, India. *Journal of Agrometeorology,* 22 (2): 203:206.	6.64	http://krishi.icar.gov.in/jspui/handle/123456789/43019
Khulbe, R.K., Pattanayak, A., Kant, L., Bisht, G.S., Pant, M.C., Pandey, V., Kapil, R. and Mishra, N.C. (2020). Doubled haploid production in maize under sub-montane Himalayan conditions using *R1-nj*-based haploid inducer TAILP1. *Indian J. Genet.*, 80(3): 261-266.	6.47	http://krishi.icar.gov.in/jspui/handle/123456789/47349
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Bhartiya, A., Mahajan, V., Singh, G., Aditya, J.P. and Singh, S. (2020). Lentil variety VL *Masoor* 148 (VL 148). *Indian Journal of Genetics and Plant Breeding,* 80 (1): 122.	6.47	http://krishi.icar.gov.in/jspui/handle/123456789/47353
Bhartiya, A., Singh, G., Mahajan, V., Aditya, J.P., Singh, S., Jain, S.K., Stanley, J. and Pal, R.S. (2020). Black soybean (*Bhat*) variety VL *Bhat* 202 (VLB 202). *Indian Journal of Genetics and Plant Breeding,* 80 (1): 123.	6.47	http://krishi.icar.gov.in/jspui/handle/123456789/47352
Bhartiya, A., Mahajan, V., Singh, G., Aditya, J.P., Jain, S.K., Mishra, K.K., Singh, S., Khati M.S., Kanwal, C.S., Bankoti, G.S. Ram, P. (2019). Soybean variety VL Soya 89 (VLS 89). *Indian Journal of Genetics and Plant Breeding,* 79(2): 515.	6.47	http://krishi.icar.gov.in/jspui/handle/123456789/31480
Gupta, J.P., Subbanna, A.R.N.S., Stanley, J., Paschapur, A.U. and Mishra, K.K. (2020). Devising an Effective Management Strategy against Brinjal Shoot and Fruit Borer (*Leucinodes orbonalis* (Guenee)) under Hill Agriculture in Uttarakhand, Himalayas. *International Journal of Current Microbiology and Applied Sciences,* 9(11). 58-66.	6.38	http://krishi.icar.gov.in/jspui/handle/123456789/47339
Pal, R.S., Bhartiya, A., Kant, L., Aditya, J.P., Mishra, K.K. and Pattanayak, A. (2020). Common and lesser-known pulses from Northwestern Himalaya: A comparison study for quality traits. *Legume Research- An International Journal*, 43 (3): 386-393.	6.23	http://krishi.icar.gov.in/jspui/handle/123456789/30051
Subbanna, A.R.N.S., Stanley, J., Deol, A., Gupta, J.P., Mishra, P.K., Sushil, S.N., & Paschapur, A.U. (2020). Field evaluation of native white grub bio-agent, *Bacillus cereus* strain WGPSB-2 in Uttarakhand Himalayas and its impact on soil microbiota. *Journal of Entomology and Zoology Studies,* 8(5): 2334-2340.	5.53	http://krishi.icar.gov.in/jspui/handle/123456789/47340

Joshi, K. and Chandra, N. (2020). Occupational Health and Safety Issues among Hill Farm women involved in Wheat Cultivation. *Indian Journal of Extension Education,* 55(4):145-150.	5.32	http://krishi.icar.gov.in/jspui/handle/123456789/35612
Jethi, R., Joshi, P., Jalal, A., Nautiyal, P., Chandra, N. and Arya, M. (2020). Nutri-gardens: Key to Address Nutritional Needs of Hill Community *Journal of Community Mobilization and Sustainable Development,* 15(1): 259-267.	5.30	http://krishi.icar.gov.in/jspui/handle/123456789/47309
Kumar, J., Patel, N., Rajput, T.B.S., Kumari, A. and Rajput, J. (2020). Performance evaluation and calibration of soil moisture sensors for scheduling of irrigation in Brinjal crop (*Solanum Melongena L. var. Pusa Shyamla*). *Journal of Soil and Water Conservation*, 19(2):182-191.	5.08	-
Raghu, B.R., Gangwar, O.P., Bhardwaj, S.C. and Mishra K.K. (2020). Stripe rust resistance in wheat germplasm of North Western Himalayan hills. *J. Expt. Biol. Agri. Sci.* 8(2): 125-133.	5.07	-
Kant, L., Pant, S.K., Jain, S.K., Raghu, B.R., Pandey, B.D., Dayashanker, Mahanta, D., Jethi, R., Pattanayak, A., Bankoti, G.S. and Malkani, L.D. (2020). VL *Gehun* 953: A high yielding, rust-resistant, winter x spring wheat (*Triticum aestivum* L.) derivative, suitable for organic hills as well as inorganic Plains of Uttarakhand state of India. *Journal of Cereal Research,* 12(1):40-43.	4.42	http://krishi.icar.gov.in/jspui/handle/123456789/47301
Jeeva, J.C., Moharana, G. and Joshi, K. (2020). Gender Differences in Information Needs and Communication Behaviour among the Tribal Farm Families in Odisha, India. *Journal of Global Communication,* 13(1):1-19.	4.50	http://krishi.icar.gov.in/jspui/handle/123456789/39548
Jethi, R., Kant, L., Raghu, BR and Gahtyari, NC. (2020). Economic impact of high yielding rust resistant wheat varieties suitable for hill region of Uttarakhand. *Journal of Cereal Research,* 12(2):142-149.	4.42	http://krishi.icar.gov.in/jspui/handle/123456789/47311
Jethi, R., Nautiyal, P., Jalal, A., Singh, K., Arya, M., Joshi, P. and Chandra, N. (2020). Food and nutritional security through nutrition-sensitive agriculture related interventions in high hills of Uttarakhand, India. *The Anthropologist*, 39(1-3):17-25.	4.00	http://krishi.icar.gov.in/jspui/handle/123456789/47310

14.2. Book/ e-Book

Book/e-Book	Krishi Portal ID
Bhartiya, A., Aditya, J.P., Chandra, N., Kumar, J., Kant, L. and Arunava Pattanayak, A. (2020). *"Parvatiya Kshetron Ki Paramparik Falon Ka Unnat Utpadan Evam Katayee Uprant Prasanskaran Takniki Dwara Aaya Srijan"*, ICAR-VPKAS, Almora, Uttarakhand, India, p111.	http://krishi.icar.gov.in/jspui/handle/123456789/47351

14.3. Popular Articles

Popular Articles	Krishi Portal ID
Yadav, R.P., Bisht, J.K., Meena, V.S. and Parihar, M. (2020). Phal-Masala-Khadhyann ki Samekit Krishi Pranali. *Phal Phul*, 41(4): 44-45.	http://krishi.icar.gov.in/ jspui/handle/123456789/ 42981
Kumar, U., Kumar, J., Singh, S., Parihar, M., Bisht, J.K. and Pattanayak, A. (2020). Low cost polytanks for higher water productivity in hills. *Indian Farming*, 70(3): 35-37.	http://krishi.icar.gov.in/jspui/handle/123456789/45088
Bhartiya, A., Aditya, J.P., Joshi, D., Kant, L., and Kumar, J. (2020). Potential Nutri-Crops from Uttarakhand hills for diversifying food basket in a changing climate. *Indian Farmers digest*, 53(10):30-35.	http://krishi.icar.gov.in/jspui/handle/123456789/47355
Mishra, K.K. and Rajashekara, H. (2020). Button mushroom ke kavak janit rog va prabandhan. *Kisan Bharti*. 51(4): 35-37.	http://krishi.icar.gov.in/jspui/handle/123456789/31485
Mishra, K.K. (2020). Entomopathic mushroom: *Cordyceps sinensis*. *Indian Farmers Digest*. 53 (12):38-41.	http://krishi.icar.gov.in/jspui/handle/123456789/47333

Reddy, K.V.N. and Paschapur, A.U. (2020). Employing environmentally safer and novel synthetic insecticides in organic farming for eco-friendly pest management. *Indian Farmer,* 7(04): 267-272.	http://krishi.icar.gov.in/jspui/handle/123456789/47337
Paschapur, A.U., Nikhil, Raj M., Samal, I. and Reddy, K.V.N. (2020). Employing Natural enemies for ecofriendly pest management in hill agriculture in Indian Himalayas. *Indian Farmer,* 7(06): 519-525.	http://krishi.icar.gov.in/jspui/handle/123456789/47336
Singh, S. (2020). रबी फसलों की कटाई, गहाई और भंडारण में ध्यान देने योग्य बातें, 26 April 2020. Headlines 247. http://www.headlines247.in/rabi-faslon-ki-katayi-gahayi-aur-bhandaran-me-dhayaan-dene-yogya-baaten/	http://krishi.icar.gov.in/jspui/handle/123456789/49422
Samal, I., Paschapur, A.U. and Nikhil, Raj M. (2020). Managing the Menance of Melon Fruit Flies, Bactroceracucurbitae (Tephritidae, Diptera). *Indian Farmer,* 7(07): 643-647.	-
Kant, L., Khulbe, R.K., Joshi, K., Meena, VS.., Chaudhari, G.V. and Pattanayak, A. (2020). Moving towards good agricultural practices (GAPs) through more scientific information: A success story. *Indian Farming,* 70(06): 32–33.	http://krishi.icar.gov.in/jspui/handle/123456789/47420
Verma, N, Chaudhary, V., Ghassal, P.C. and Joshi, K. (2020). *Krishirat mahilaon mein kathin shram se utpann samsyaein evam nidaan. In:* Meena, L., Mishra, D., Singh. P.P., Meena, L.K., Meena, A.L. and Singh, S.P. (Eds) *Samekit Krishi Pranaali dwaara aay mein vridhi*. pp 49-53. IIFSR Modipuram.	https://krishi.icar.gov.in/jspui/handle/123456789/47341
Jethi, R., Jalal, A. and Chandra, N. (2020). *Pravatiya kshetron mein mahilaon hetu poshan suraksha: Dasha evam Disha*. *Kisan Bharti,* 51(4), pp: 25-29.	http://krishi.icar.gov.in/jspui/handle/123456789/47335
Jethi, R., Jalal, A., Chandra, N. and Joshi, P. (2020). Women empowerment through household food and nutritional security: A case study from high hills of Uttarakhand. *Indian Farmers' Digest,* 53(3), pp:28-30.	http://krishi.icar.gov.in/jspui/handle/123456789/47313
Joshi, P., Jalal, A., Jethi, R and Nautiyal, P. (2020). *Poshan Suraksha mein Phalon ka yogdaan. Phal-Phool*, 41(2), pp:32-34.	http://krishi.icar.gov.in/jspui/handle/123456789/47332
Joshi, P., Jethi, R and Mahra, G. (2020). *Mahilaon hetu kam shram mein adhik Karya shamta: Chunautiyaan evan Sambhawanayan*. Modern Kheti, Cover story in November 30, 2020.	http://krishi.icar.gov.in/jspui/handle/123456789/47361
Aditya J.P. and Bhartiya A. (2020). Bio-fortification of Crops: An Avenue to Alleviate Malnutrition. Indian Farmers Digest, 53 (5):4-10.	http://krishi.icar.gov.in/jspui/handle/123456789/49627
Ganesh, V.C. and Hedau, N.K. (2020). Edema: A Physiological Disorder of Plant Grown Under Protected Conditions. *Agriculture Observer,* 1(5): 20-25.	http://krishi.icar.gov.in/jspui/handle/123456789/42888
Mishra, K.K. and Hedau, N.K. (2020). *Sabjiyon me Rogon ka Jaivik Prabandhan. Kasan Bharti*, p 31.	http://krishi.icar.gov.in/jspui/handle/123456789/47414

14.4. Book Chapters

Book Chapters	Krishi Portal ID
Abhilash, Rani A., Kumari, A. and Kumar, J. (2020). Water resource and use efficiency under changing climate. *In: Resource Use Efficiency in Agriculture* (pp. 519-76).	-
Jatav, H.S., Sharma, L.D., Sadhukhan, R., Singh, S.K., Singh, S., Rajput, V.D., Parihar, M., Jatav, S.S., Jinger, D. and Kumar, S. (2020). An overview of micronutrients: Prospects and implication in crop production. *In:* Aftab, T. & Hakeem, K.R. (Eds) *Plant Micronutrients*, (pp. 1-30) Springer, Singapore.	-
Jatav, H.S., Singh, S.K., Gautam, M.K., Khan, M., Kumar, S., Rajput, V.D., Khan, M.A., Jat, L.K**.,** Parihar, M., Khatik, C.L. and Jatav, G.K. (2020). Zinc solubilization and mobilization: A promising approach for cereals biofortification. *In: Advances in Plant Microbiome and Sustainable Agriculture* (pp. 41-64). Springer, Singapore.	-

Khati, P., Mishra, P.K., Parihar, M., Kumari, A., Joshi, S., Bisht, J.K. and Pattanayak, A. (2020). Potassium solubilization and mobilization: Functional impact on plant growth for sustainable agriculture. *In:* Yadav, A., Rastegari, A., Yadav, N., Kour, D. (Eds) *Advances in Plant Microbiome and Sustainable Agriculture*. *Microorganisms for Sustainability*, vol 20:21-39. Springer, Singapore.	http://krishi.icar.gov.in/ jspui/ handle/123456789/ 43318
Parihar, M., Khati, P., Kumari, A., Mishra, P.K., Meena, V. S., Singh, A.K., Choudhary, M., Bisht, J.K., Ram, H. and Pattanayak, A. (2020). Arbuscular mycorrhizal fungi: Abundance, interaction with plants and potential biological applications. *In:* Yadav, A.N., Rastegari, A.A., Yadav, N. & Kour D. (Eds) *Advances in Plant Microbiome and Sustainable Agriculture, Microorganisms for Sustainability* (pp.105-143), Springer Nature Singapore Pte Ltd., https://doi.org/10.1007/978-981-15-3208-5_5, ISBN: 978-981-15-3207-8.	http://krishi.icar.gov.in/jspui/ handle/123456789/42982
Parihar, M., Chitara, M., Khati, P., Kumari, A., Mishra, P.K., Rakshit, A., Rana, K., Meena, V.S., Singh, A.K., Choudhary, M. and Bisht, J.K. (2020). Arbuscular mycorrhizal fungi: Abundance, interaction with plants and potential biological applications. *In: Advances in Plant Microbiome and Sustainable Agriculture* (pp. 105-143). Springer, Singapore.	http://krishi.icar.gov.in/spui/ handle/123456789/ 42982
Mishra, P.K., Joshi, S., Gangola, S., Khati, P., Bisht, J.K., Pattanayak, A. (2020). Psychrotolerant microbes: Characterization, conservation, strain improvements, mass production, and commercialization *In:* Goel, R., Soni, Ravindra & Suyal, Deep Chandra (Eds.), *Microbiological Advancements for Higher Altitude Agro-ecosystems & Sustainability*, *Rhizosphere Biology*, Springer Nature Singapore Pte Ltd., DOI:10.1007/978-981-15-1902-4_12.	http://krishi.icar.gov.in/jspui/ handle/123456789/41297
Singh, S. and Nath, S. (2020). *Aay Vardhihetu Alpparyukt Faslon ke Mulyavardhit Utpad*. *In: Parvatiya Kshetron ki Paramprik Faslon ka Unnat Utpadan env Katai Uprant Prasanskaran Takniki dwara Aay Sarjan*, (pp. 105-111) Bhartiya, A., Aditya, J.P., Chandra, N., Kumar, J., Kant, L. & A. Pattanayak (Eds), ICAR-VPKAS, Almora.	http://krishi.icar.gov.in/jspui/ handle/123456789/49387
Shyam, Nath, Kumar, J., Singh, S. and Bisht, J.K. (2020). *Parmparik Faslon ki Katai Uprant Prasanskaran Prodhogiki*. *In: Parvatiya Kshetron ki Paramprik Faslon ka Unnat Utpadan env Katai Uprant Prasanskaran Takniki dwara Aay Sarjan*, (pp. 98-104) Bhartiya, A., Aditya, J.P., Chandra, N., Kumar, J., Kant, L. & A. Pattanayak (Eds), ICAR-VPKAS, Almora.	http://krishi.icar.gov.in/jspui/ handle/123456789/52735
Yadav, R.P., Panday, S.C., Kumar, J., Bisht, J.K., Meena, V.S., Choudhary, M., Nath, S., Parihar, M. and Meena, R.P. (2020). Climatic variation and its impacts on yield and water requirement of crops in Indian Central Himalaya (pp. 1-19). *In: Agrometeorology* Meena, R.S. (Ed) DOI: http://dx.doi.org/10.5772/intechopen.94076	http://krishi.icar.gov.in/jspui/ handle/123456789/45371
Subbanna, A.R.N.S., Stanley, J., Rajasekhara, H., Mishra, K. K., Pattanayak, A., & Bhowmick, R. (2020). Perspectives of microbial metabolites as pesticides in agricultural pest management. *Co-Evolution of Secondary Metabolite*s, 925-952.	-
Kushagra, J. and Nath, S. (2020). Drudgery in hill agriculture and its management. *In:* Training manual on Improved Agricultural Technologies for Income Enhancement of NEH farmers (February 11-15, 2020), 128-134.	-
Mahra, G., Joshi, P., Jethi, R and Punitha, P. (2020). Sustainable agriculture for food and nutritional security: Issues, challenges and way forward. *In: Technological Development in Agricultural Extension*. Shrivastava, P & Singh (Eds) U.K., pp. 43-45. Published by AkiNik Publication. New Delhi.	http://krishi.icar.gov.in/jspui/ handle/123456789/51140
Khulbe, R.K., Pattanayak, A., Sharma, D. (2020). Biofortification of maize using accelerated breeding tools. *In:* Accelerated Gosal, S., Wani, S. (Eds), Plant Breeding, Volume 1. pp. 293-308 Springer, Cham.	http://krishi.icar.gov.in/jspui/ handle/123456789/47376

Muthusamy, V., Zunjare, R.U., Das, A.K., Mehta, B.K., Dutta, S., Gowda, M., Duo H., Chand, G., Bhatt, V., Kasana R., Talukder, M.Z.A., Ismail, M.R., Baveja A., Chauhan, H.S., Singh, B., Katral, A., Mishra, S.J., Gain, N., Chhabra, R., Sarika, K., Sharma, D. and Hossain, F. (2020) Biofortified maize hybrids for nutritional security. *In*: Training manual of ACARE sponsored short-term training on 'Heterosis Breeding: Principles and Practices' held at Yezin Agricultural University, Yezin, Nay Pyi Taw, Myanmar, 24 Feb-06 Mar, 2020, pp. 71-77.	-
Sharma, D., Gahtyari, N.C., Chhabra, R., Kumar, D. (2020). Role of microbes in improving plant growth and soil health for sustainable agriculture. *In:* Advances in Plant Microbiome and Sustainable Agriculture. Microorganisms for Sustainability, Yadav A., Rastegari A., Yadav N., Kour D. (Eds) vol 19. Springer, Singapore.	http://krishi.icar.gov.in/jspui/handle/123456789/43317
Sood, S., Joshi, D.C. and Pattanayak, A. (2020). Breeding advances in barnyard millet. *In: Accelerated Plant Breeding Volume 1 cereal crops* (Gosal SS, Wani SH (ed), Springer, Germany. Pp 391-409	-
Kumar, D., Dutt, S., Raigond, P., Changan, SS., Lal, M.K., Sharma, D. and Singh, B. (2020). Potato probiotics for human health. *In:* Raigond, P., Singh, B., Dutt, S., Chakrabart, S.K. (Eds) Potato. Springer, Singapore.	-
Sharma, B. and Kumari, A. (2020). Role of post harvest physiology in evolution of transgenic crops. *In:* Plant Breeding: Current and Future Views. pp 1-21.	http://krishi.icar.gov.in/jspui/handle/123456789/45369

14.6. Institute Publications

- *Krishi* Calender 2020-21
- VPKAS Newsletter Vol. 23 (No. 1 & 2)

14.7. Extension Literature

- *Kesar ki vagyanic kheti* (122/2020).
- *Tamatar ki phasal mein pinworm (Tuta absoluta) ka samekit prabhandhan* (123/2020).
- *Makka ki phasal mein fall armyworm* (*Spodoptera frugiperda*) *ka samekit prabhandhan* (124/2020).
- *Rajma ki Phasal mein katua keet (Agrotis segetum) ka samekit prabhandhan* (125/2020).
- *Health Boosting Nutri Crops of Uttarakhand Himalayas* (126/2020).

14.9. Peer recognition to ICAR-VPKAS scientists

Above NAAS Rating 8

Journal of Cleaner Production (12.40), Science of the Total Environment (10.90), Renewable Energy: An International Journal (Solar and Wind Technology) (10.36), Chemosphere (10.21), Environmental Research (9.84), PLOSOne (8.81), Applied Soil Ecology (8.79), Plant Physiology & Biochemistry (8.72), Archives of Agronomy and Soil Science (8.14), Nature Scientific Report (8.0)

Above NAAS Rating 7

Journal of Microbiology (7.92), Crop Protection (7.83), Journal of Economic Entomology (7.82), Agroforestry Systems (7.79), Environmental Monitoring and Assessment (7.69), Scientia Horticulture (7.62), Current Microbiology (7.32), 3Biotech (7.36), Journal of Apicultural Research (7.36), Environmental Engineering and Management Journal (7.33), Agroforestry Systems (7.20), Journal of Mountain Science (7.14), PlosOne (8.78), Agroforestry Systems (7.79), Journal of Mountain Science (7.42),

Above NAAS Rating 6

Journal of Genetics (6.99), Biocontrol Science and Technology (6.92), Journal of Environmental Biology (6.70), Acta Agriculturae Scandinavica, Section B - Plant Soil Science (6.65), National Academy of Sciences Section Biology (6.37), Indian Journal of Traditional Knowledge (6.0)

15. List of Ongoing Projects

15.1. Institute's Core Research Projects

15.1.1. Enhancement in the Productivity of Major Hill Crops

- ❖ Genetic Enhancement of Maize for Yield and Nutritional Quality Using Integrated Breeding Approach *[Dr. R.K. Khulbe (PI)]*
  - **Sub Project -** Identification of Potential Lines and Hybrid Combination for high Fe and Zn content in maize through biochemical and molecular approach *[Dr. Devender Sharma (PI)]*
- ❖ Enhancement of Genetic Potency of Rice for Productivity, Biotic and Abiotic Stresses for North West Himalayas*[Dr. J.P. Aditya (PI)]*
- ❖ Genetic Improvement of Wheat and Barley for Higher Productivity, Quality Traits, Abiotic and Biotic Stresses. *[Dr. L. Kant (PI)]*
  - **Sub Project -**Inheritance studies for transgenerational stress memory in wheat induced by late sowing [*Dr. Navin Chander Gahtyari (PI)]*
- ❖ Trait Mining and Genetic Improvement of Small Millets and Potential Crops in the Context of Climate Change *[Dr. D.C. Joshi (PI)]*
- ❖ Genetic Improvement of Pulses & Oilseeds for Higher Productivity, Quality, Biotic & Abiotic Stresses for North-Western Himalayan Hills *[Dr.Anuradha Bhartiya (PI)]*
- ❖ Enhancement of Genetic Potency in Important Vegetables Crops for North Western Himalayan Ecosystem *[Drs. N.K. Hedau (PI)]*
  - **Sub Project:** Heterosis Breeding in Onion [*Dr. Chaudhari Ganesh V. (PI)]*
  - **Sub- project:** Capsicum Heterosis Breeding [*Dr. Chaudhari Ganesh V. (PI)]*
  - **Sub-project:** Collection Evaluation, Identification and Documentation of Underutilized Vegetable Crops for North-West Himalayan Ecosystem *[Dr. Rahul Dev (PI)]*
- ❖ Germplasm Evaluation in Major Hill Crops for Nutritional and Physiological Parameters Through Basic Techniques *[Dr. Ramesh Singh Pal (PI)]*
- ❖ **Sub-project:** Evaluation and Identification of Major Hill Crops of North-West Himalayas for Abiotic Stress Management. *[Dr. Asha kumara (PI)]*
- ❖ **Sub-project:** Identification and Utilization of Important Genes/Alleles/Markers in Hill Crops *[Dr. Rakesh Bhowmick (PI)]*
- ❖ Seed Production *[Dr. L. Kant (PI)]*

15.1.2. Natural Resource Management for Enhancing the Productivity

- ❖ Crop Management for Higher Soil Quality and Sustainability in Indian Himalayas *[Dr. Dibakar Mahanta (PI)]*
- ❖ Enhancing Productivity and Profitability of Major Hill Crops through Efficient Resource Utilization *[Dr. Sher Singh (PI)]*
  - **Sub Project:** Identification of micro watershed (natural spring) using Remote sensing & GIS technique and its runoff estimation for potential water harvesting [*Er. Utkarsh Kumar (PI)]*
- ❖ Farm Mechanization and Post-harvest Management for Mountain Regions *[Er. Shyam Nath (PI)]*
- ❖ Agro-forestry and Fodder Production Management with Emphasis on Utilization of Marginal Lands in Hills *[Dr. J.K. Bisht (PI)]*
  - **Sub- Project:** Evaluation and Refinement

of Suitable Agroforestry Practices for hills [*Dr. R.P. Yadav (PI)]*

- Water Harvesting and Effective Utilization of Water for Enhancing Crop Productivity and Input Use Efficiency *[Dr. S.C. Panday (PI)]*

15.1.3. Integrated Management of Diseases and Pests of Hill Crops

- Race profiling, variability and management of major plant pathogens of hill crops[*Dr. Rajashekara, H. (PI)]*
- Bio-intensive management of major polyphagous pests of Uttarakhand hills*[Dr. A.R.N.S. Subbanna (PI)]*
- Studies on physico-chemical properties and microbial dynamics of compost and casing soil in relation to fructification and yield of white button mushroom (*Agaricus bisporus*) [*Dr. K. K. Mishra (PI)]*

15.1.4. Socio-economic Studies, Transfer of Technology and Information Technology

- Impact of Constrained and Unconstrained Choices on Adoption of Improved Agricultural Practices by Farmers *[Dr. Renu Jethi (PI)]*
- Technological Interventions for Mitigating Drudgery and Improving Nutritional Status of Hill Farmwomen *[Dr. Kushagra Joshi (PI)]*

15.2. Externally Funded Projects

15.2.1. ICAR-NASF Funded Project

- Utilization and Refinement of Haploid/ Doubled haploid Induction Systems in Rice, Wheat and Maize Using In-Vitro and Molecular Strategies *[Drs. R.K. Khulbe & A. Pattanayak]*

15.2.2. National Food Security Mission (NFSM) Funded

- Enhancing Breeder Seed Production to Increase Indigenous Production of Millets in India *[Dr. Dinesh Chandra Joshi]*

15.2.3. Consortium Research Platform (CRP) Projects

- ICAR-CRP on Biofortification in Selected Crops for Nutritional Security *[Drs. R.K. Khulbe, R.S. Pal & Rakesh Bhowmick]*
- ICAR-CRP on Molecular Breeding in Maize *[Drs. R.K. Khulbe, R.S. Pal, Rajashekara, H. & Rakesh Bhowmick]*
- CRP on Agrobiodiversity, PGR Management, Component II – Wheat *[Drs. Lakshmi Kant & K.K. Mishra]*
- CRP on Molecular Breeding Wheat *[Drs. Lakshmi Kant, K.K. Mishra & Rakesh Bhowmick]*

15.2.4. UN Environment - GEF Project

- Mainstreaming Agricultural Biodiversity Conservation and Utilization in Agricultural Sector to Ensure Ecosystem Services and Reduce Vulnerability *[Drs. A. Bhartiya, Kushagra Joshi & Jitendra Kumar]*

15.2.5. PVP-DUS Test Through ICAR-SAU System

- DUS/GOT trials in kidney bean *[Dr. Anuradha Bhartiya]*

15.2.6. DBT Funded Project

- Network Project on Genetic Enhancement of Minor Pulses *[Dr. D C Joshi]*
- Collection and Characterization of Indigenous Shiitake (*Lentinula edodes)* and DNA Barcoding of Oyster *(Pleurotus* spp.*)* Mushroom Germplasm for Commercial Exploitation *[Dr K. K. Mishra]*.

15.2.7. AICRP/ Network Projects

- Use of Plastics in Agriculture Particularly in Protected Cultivation, Water Harvesting and Packaging (AICRP on PEASEM) *[Drs. Jitendra Kumar (PI since 30 May 2020), Sher Singh (PI upto 29 May 2020 & Co-PI since 30 May 2020), Shyam Nath (Co-PI) and Er. Utkarsh Kumar (Co-PI since 01 April 2020)]*
- Post Harvest Technology for Value Addition and Marketing of Agricultural Produce (AICRP on PHET) *[Drs. Shyam Nath (PI since 09 Jul 2020), Dr. Sher Singh (PI upto 08 Jul 2020 & Co-PI since 09 Jul. 2020), Dr. Kushagra Joshi (Co-PI), Er. Jitendra Kumar (Co-PI) & Dr.*

J.K. Bisht (Associated Scientist)]

- All India Network Project on Soil Arthropod Pests *[Drs. A.R.N.S. Subbanna& Amit Paschapur]*
- Network Programme on Organic Farming (NPOF) *[Drs. Dibakar Mahanta, P.K. Mishra, K.K. Mishra, J. Stanley (upto….), V.S. Meena (upto May 26, 2020), Manoj Parihar & Priyanka Khati (on maternity/child care leave)]*
- All India Coordinated Research Project *on Mushroom [Dr. K. K. Mishra]*

15.2.8. Network Project on AMAAS

- Developing PGPR Consortia for Enhanced Micronutrient (iron and zinc) Uptake and Yield of Finger Millet (*Eleusine coracana*) in Hilly Areas *[Drs. Pankaj K. Mishra & V.S. Meena (upto May 26, 2020)]*

15.2.9. NICRA Project under Competitive Grants Component (CGS)

- Design & Development of Protective Structures for High Values Crops to Reduce Damage from Hail and Frost *[Dr. Sher Singh]*

15.2.10. National Mission on Himalayan Studies (NMHS) Project

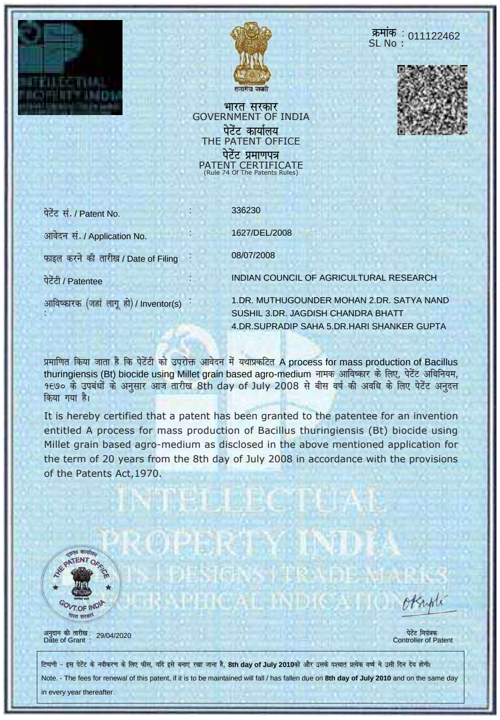
- Strategies to Improve Health and Nutritional Status of Hill Farm Women through Technological Interventions *[Drs. Renu Jethi, Pankaj Nautiyal, Manisha Arya & Prathibha Joshi]*
- Characterization of Kidney Bean (Rajmah) Rhizosphere Microbiome from Higher Altitude of Indian Central Himalaya *[Dr. Pankaj K. Mishra]*

15.2.11. National Mission for Sustaining the Himalayan Ecosystem (NMHSE) Project

- National Mission for Sustaining the Himalayan Ecosystem: Taskforce 6 (Agriculture) for Lower and Middle Himalaya *[Drs. A. Pattanayak, S.C. Panday, Kushagra Joshi, V.S. Meena & J. Stanley]*

16. Consultancy, Patents & Commercialization of Technology

16.1. Grant of Patent


क्रमांक : 011122462
SL No :

भारत सरकार
GOVERNMENT OF INDIA
पेटेंट कार्यालय
THE PATENT OFFICE
पेटेंट प्रमाणपत्र
PATENT CERTIFICATE
(Rule 74 Of The Patents Rules)

पेटेंट सं. / Patent No.	:	336230
आवेदन सं. / Application No.	:	1627/DEL/2008
फाइल करने की तारीख / Date of Filing	:	08/07/2008
पेटेंटी / Patentee	:	INDIAN COUNCIL OF AGRICULTURAL RESEARCH
आविष्कारक (जहां लागू हो) / Inventor(s) :	:	1.DR. MUTHUGOUNDER MOHAN 2.DR. SATYA NAND SUSHIL 3.DR. JAGDISH CHANDRA BHATT 4.DR.SUPRADIP SAHA 5.DR.HARI SHANKER GUPTA

प्रमाणित किया जाता है कि पेटेंटी को उपरोक्त आवेदन में यथाप्रकटित A process for mass production of Bacillus thuringiensis (Bt) biocide using Millet grain based agro-medium नामक आविष्कार के लिए, पेटेंट अधिनियम, १९७० के उपबंधों के अनुसार आज तारीख 8th day of July 2008 से बीस वर्ष की अवधि के लिए पेटेंट अनुदत्त किया गया है।

It is hereby certified that a patent has been granted to the patentee for an invention entitled A process for mass production of Bacillus thuringiensis (Bt) biocide using Millet grain based agro-medium as disclosed in the above mentioned application for the term of 20 years from the 8th day of July 2008 in accordance with the provisions of the Patents Act,1970.

अनुदान की तारीख : 29/04/2020
Date of Grant :

पेटेंट नियंत्रक
Controller of Patent

टिप्पणी - इस पेटेंट के नवीकरण के लिए फीस, यदि इसे बनाए रखा जाना है, **8th day of July 2010**को और उसके पश्चात प्रत्येक वर्ष्र मे उसी दिन देय होगी।
Note. - The fees for renewal of this patent, if it is to be maintained will fall / has fallen due on **8th day of July 2010** and on the same day in every year thereafter.

An application No. 1627/DEL/2008 dated July 8, 2008 entitled "A process for the mass production of *Bacillus thuringiensis* (Bt) biocide using millet grain based agro-medium" invented by ICAR-VPKAS, Almora has been granted patent No. 336230.

The invention employs cost effective high yielding agro based growth medium for the early, profuse sporulation and the process for the mass production of bio-insecticide, *Bacillus thuringiensis.* The millet based agro based medium comprised finger millet grain powder; defatted soybean, etc. This medium is supplemented with solid media with crop wastes to make it solid for mass production. The media described in this present invention is suitable for the efficient mass production of Bt spore-crystal toxin used for the management of insect pests.

16.2. Commercialization of Institute Varieties and Machines

- Material Transfer Agreement (MTA) was signed for commercialization of "Vivek Maize Hybrid 45" and "Vivek Maize Hybrid 53" with *Bhartiya Beej Nigam* Ltd. for 5 years, Technology License Agreement (TLA) was signed for commercialization of for "VL Small Tool Kit" with M/s Himalayan Hi-Tech Nurseries for 3 years, TLA was signed for commercialization of "VL White Grub Beetle Trap- 1" with S.S.K. Traders/Manufacturers, Almora, Uttarakhand for 4 years, TLA was signed for commercialization of "VL Metallic Plough" with M/s Himalayan Hi-Tech Nurseries for 3 years,
- MoA for VL Solar Drier developed under AICRP
- PET was signed with M/s Himalayan Hi-Tech Nurseries, Haldwani for 3 years.
- MoA was signed between ICAR-VPKAS and M/s Punjab Agricultural Implements Pvt. Ltd., Saharanpur for VL Paddy Thresher for 3 years.

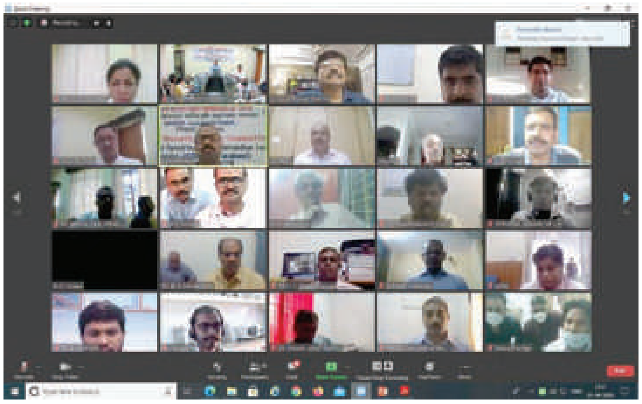
17. RAC & IRC Meetings

17.1. Research Advisory Committee (RAC) Meeting

The XXIV Research Advisory Committee (RAC) meeting of VPKAS, Almora was held through VC on September 25, 2020 under the Chairmanship of Dr. K.R. Dhiman, Ex. Vice Chancellor, Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan. The meeting was graced by RAC members were Dr. Hemendra Chandra Bhattacharyya, Ex. Director of Extension Education, Assam Agricultural University, Jorhat**;** Dr. Arun Kumar Sharma, Ex. Director NBAIM, Mau; Dr. K.K. Satpathy, Ex. Director NINFET, Kolkata; Dr. J.P. Singh, Professor (Horticulture), College of Agriculture, GBPUA&T, Pantnagar; Dr. B.S. Mahapatra, Prof. Agronomy, GBPUA&T, Pantnagar , Dr. Jai C. Rana, National Coordinator, UN Environment-GEF Project Bioversity International-India and farmer members Shri Nagendra Kumar and Shri Shusheel Tyagi. The meeting was also attended by HoDs and all scientists of the Institute through VC.

17.2. Evaluation of Experiments by Field Monitoring Team

The monitoring of field experiments was conducted in *rabi* 2019-20 on April 23, 2020 and *kharif* 2020 at various time due to Covid-19 pandemic situation at experimental farm, Hawalbag. All the scientists participated and monitored the experiments. The progress was reviewed by the Director.

RAC Meeting at ICAR-VPKAS, Almora



Field monitoring at experimental farm, Hawalbag

17.3. Institute Research Council (IRC) Meeting

The Institute Research Council (IRC) meeting for *kharif* 2020 and *rabi* 2020-21 were held on May 12, 13 and 16, 2020 and October 17, 2020, respectively under the Chairmanship of Dr. Lakshmi Kant, Director ICAR-VPKAS, Almora by following the guidelines of COVID 19. The progress of all research projects was reviewed and new experiments were discussed. The projects for new EFC were thouroghly disscussed and finalized.

***Kharif* 2020 IRC meetings**

***Rabi* 2020-21 IRC meetings**

18. Participation of Scientists in Conferences, Seminar, Webinar, Workshop, Symposia & Meetings

Name	Conference/Seminar/Webinar/Workshop/Symposia/ Meetings
International	
Drs. Kushagra Joshi, Hanuman Ram and DC Mishra	Global Potato Conclave 2020 orgnised by Indian Potato Association and ICAR CPRI, Shimla at Gandhinagar during January 28-30, 2020.
Dr. A.R.N.S. Subbanna	XVII AZRA International Conference on "Frontier Research in Applied Zoology and Insect Pest Management Strategies: A way Forward for Food and Nutritional Security" at UAS, Raichur during February12-14, 2020.
Dr. M. Parihar	International webinar on Reinventing Agricultural Skill in the time of Pandemic: Research and Extension Services organized by Association of Agriculture, Environment and Biotechnology, New Delhi on June 16, 2020.
Drs. N.K. Hedau, Ganesh V. Chaudhari, R.P. Yadav, Rahul Dev, Manoj Parihar	International web-conference on New Trends in Agriculture, Environmental & Biological Sciences for Inclusive Development (NTAEBSID-2020) organized by Agro Environmental Development Society (AEDS), during June 21-22, 2020.
Dr. D. Sharma	International webinar on Nutritious Maize: Technologies, Development and Availability in South Asia organized by CIMMYT during July 21-23, 2020.
Drs. N.K. Hedau, Ganesh V. Chaudhari	International webinar on Climate Smart Agriculture (Climate Resilient Crops for Food and Nutritional Security) organized by MPKV, Rahuri on July 22, 2020.
Drs. S.C. Panday, R.P. Yadav, M. Parihar, Jitendra Kumar and U Kumar	International webinar on "Land Degradation Neutrality" organized by Indian Association of Soil and Water Conservation (IASWC) and Indian Council of Forestry Research and Education (ICFRE), Dehradun during July 22-24, 2020.
Drs. M. Choudhary and M. Parihar	International web-conference on Soil Health Management for Sustainable Crop Productivity organised by Mandan Bharti Agriculture College, Agwanpur, Saharsa, Bihar during September 7-8, 2020.
Dr. Pankaj K. Mishra	International webinar on Integrating Energy, Climate Change and Development organized by Manipur Univeristy on September 8, 2020.
Dr. M. Parihar	International web-conference on Resource Management and Biodiversity Conservation to Achieve Sustainable Development Goals organised by Academy of Natural Resource Conservation and Management, Lucknow during September 11-12, 2020.
Drs. M. Choudhary and M. Parihar	International webinar on Soil Spectroscopy: An Emerging Technique for Rapid Soil Health Assessment organised by ICAR Indian Institute of Soil Science, Bhopal & World Agroforestry (ICRAF), Nairobi on October 1, 2020.
Dr. B.M. Pandey	International conference on Role of Basic and Applied Sciences in Human Well Being organised by Alumni Almamater Advancement Association (4A) Pantnagar during November 23-24, 2020.
Dr. Devender Sharma	International E-conference on Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity organized by University of Horticultural Science, Bagalkot during November 24-27, 2020.
Dr. Pankaj Kumar Mishra	International webinar on Pulses to keep soil alive and protect biodiversity organized by ANGRAU, Hyderabad and Asisan PGPR Society, USA on December 4, 2020.
Drs. J.P. Aditya & Asha Kumari	International Plant Physiology virtual conference-2020 (IPPVC- 2020) on Prospects of Plant Physiology for Climate Proofing Agriculture organized by Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu & Indian Society for Plant Physiology (ISPP), New Delhi, during December 6-7, 2020.
National	
Dr. Jitendra Kumar	Young science award programme under agriculture and forestry science section of Indian Science Congress during January 3-7, 2020.

Dr. R.K. Khulbe	*Kharif* Seed Meeting at Directorate of Agriculture, Dehradun on January 20, 2020.
Er. Utkarsh Kumar	SPARC project sponsored workshop on Securing Water for Agricultural and Food Sustainability: Developing Trans disciplinary Approach to Groundwater Management at G B Pant University of Agriculture and Technology, Pantnagar on January 20, 2020.
Er. Utkarsh Kumar	SPARC workshop: Recharge Process of Springs and Its Management to Mitigate Anthropogenic and Climate Change Impact for Water Security: A case study in part of Kumaun Lesser Himalaya, India at GBPUA&T, Pantnagar during January 21-22, 2020.
Drs. Sher Singh and Shyam Nath	35th Annual Workshop of AICRP on Post-harvest Engineering & Technology, JNKVV, Jabalpur during January 23-25, 2020.
Dr. Jitendra Kumar, V.S. Meena, A.R.N.S. Subbanna, Ashish Kumar Singh, Utkarsh Kumar	Institute stall exhibition of tableau presentation in Republic Day Parade at Almora Uttarakhand on January 26, 2020.
Dr. R.P. Yadav	"Webcast of Hon'ble Prime Minister" in potato conclave on January 28, 2019.
Dr Renu Jethi	3rd Monitoring & Evaluation Workshops 2020 at Indian National Science Academy on January 28-29, 2020.
Dr. S.C. Panday	Conference on Resource Conservation for Soil Security and *Jalshakt*i: Farmers Perspective in Bundelkhand (RCSSJ-2020) at Datia Bundelkhand, Madhya Pradesh during February 3 to 5, 2020.
Dr. R.K. Khulbe	NASH DH Maize project partners meeting at KAB II, New Delhi on February 10, 2020.
Drs. J K Bisht and R.P. Yadav	Press-Scientist-Farmers meeting related to wild animals problem in Uttarakhand at ICAR-VPKAS, Almora on February 11, 2020.
Dr. R.K. Khulbe	Annual Review meeting of NASH DH Maize project at NASC Complex, New Delhi on February 11, 2020.
Dr. B.M. Pandey	Monitoring of NFSM activities at Haridwar and Dehradun as a member of National Level Monitoring Team during February 10-14, 2020.
Dr. R.K. Khulbe	*Kisan Mela* organized by ICAR RC NEH Lembucherra at Agartala (Tripura) on February 13, 2020.
Dr. J. K. Bisht	Participated in Radio *Kishan Divash*. AIR, Almora on February 15, 2020.
Er. Utkarsh Kumar	National Conference on Geospatial Technologies at ICAR-NAARM Hyderabad during February 20-21, 2020.
Dr. B.M. Pandey	Meeting with Director Agriculture, Govt. of Uttarakhand regarding various issue of NFSM on February 14, 2020.
Dr. B.M. Pandey	Meeting under the Chair of Chief Secretary, Govt. of Uttarakhand for finalization of Hemp Policy on February 25, 2020.
Drs. B.M. Pandey, Kushagra Joshi, Hanuman Ram and Ashish Kumar Singh	Pusa *Krishi Unnati mela* and organised stall of tribal farmers under TSP during March 1-3, 2020.
Drs. Renu Jethi and A.R.N.S. Subbanna	GBPUA&T, Pantnagar *Kisan Mela* and exhibition during March 2-6, 2020.
Dr. S.C. Panday	Meeting of advisory committee of Community development through polytechnic at Government girl's polytechnic college, Pataldevi, Almora on March 6, 2020.
Dr. R.K. Khulbe	Advisory committee meeting of NASH DH Maize project at ICAR-NRRI, Cuttack on March 6,
Dr. J.K. Bisht	Online meeting with DDG, Crop Science, Krishi Bhawan, New Delhi on March 18, 2020.
Dr. J.K. Bisht	Online meeting with DG, ICAR, Krishi Bhawan, New Delhi on March 19, 2020 & April 10, 2020.
Dr. J.K. Bisht	Online meeting with PC, AICRP on forage crops. IGFRI, Jhansi on April 16, 2020.
Drs. R.K. Khulbe, Devender Sharma, Rajashekara, H.	Online annual group maize workshop during April 20-22, 2020.
Drs. R.K. Khulbe, J.P. Aditya, Anuradha Bhartiya, Devender Sharma	Online *kharif* SVT workshop on May 18, 2020.
Drs. R.K. Khulbe, J.P. Aditya	Online SVRC meeting on May 19, 2020.
Dr. K.K. Mishra & Jeevan B.	50th Annual group meeting of AICRP on Soybean on May 20, 2020.

Dr. Anuradha Bhartiya	Online workshop of UNEP-GEF project on May 26, 2020.
Dr. Rajashekara, H.	Online annual group small millets workshop during May 28-29, 2020.
Drs. J. K. Bisht and R.P. Yadav	Online national annual AICRP Forage Crops *kharif* meeting on June 01, 2020.
Dr. Pankaj K. Mishra	Online meeting of experts on ICAR-KRISHI Geospatial data infrastructure and applications -A way forward under ICAR funded project entitled ICAR Research Data Repository for Knowledge management on June 2, 2020.
Dr. D. Sharma	National webinar on Issues and Solutions for Saving Biodiversity in Himalayan Region on June 5, 2020.
Dr. D. Sharma	National webinar on Applications of Biotechnological Tools in Crop Improvement during June 10-11, 2020.
Dr. J. K. Bisht	Online meeting regarding collaboration with DG, ICAR, Krishi Bhawan, New Delhi. June 16, 2020.
Dr. Anuradha Bhartiya	Meeting on the collaboration of other AICRPs and institutes with AICRP Forages June 16, 2020.
Drs. K.K. Mishra, Ashish Kumar Singh and Amit Paschapur	Webinar on Pesticide management in agriculture on June 19, 2020.
Dr. Renu Jethi	Special camp organised by state on *Pradhan Mantri Fasal Beema, Pradhan Mantri Kisan Samman Nidhi, Pradhan Mantri Mandhan Yojna and Kisan Credit Card Yojna* on June 19, 2020.
Dr. Anuradha Bhartiya	Online consortium meeting with Dr. Zerihun and partners from Asia & Africa for project proposal under the theme Agro-biodiversity for improved food security and Nutrition on June 24, 2020.
Dr. S.C. Panday	Online biennial chief scientists meet of AICRP—IWM held during June 24-26, 2020.
Drs. Jitendra Kumar, and Dr. Sher Singh	PMKSY meeting at conferencing room at DM Office of Almora district on June 25, 2020.
Drs. Sher Singh and Jitendra Kumar	Meeting of Uttarakhand Tea Board in Almora on June 25, 2020.
Dr. Pankaj K. Mishra	National webinar on awareness and use of CeRA Resources through J-Gate discovery platform organised by CCS Haryana Agricultural University, Hisar, in collaboration with Consortium for e-Resources in Agriculture (CeRA)- DKMA-ICAR, New Delhi & Informatics Publishing Ltd., New Delhi for agricultural library professionals of different SAUs, DAUs, CAUs, and ICAR Institutes on June 25, 2020.
Dr. N.K. Hedau	Online Xth Annual group meeting of All India Network Research Project (AINRP) on Onion and Garlic during June 22-26, 2020.
Drs. A. Bhartiya and Jitendra Kumar	Online meeting of CLIMMOB version 3 organized by BI, New Delhi under UN Environment - GEF project June 26, 2020.
Dr. A.R.N.S. Subbanna and Mr. Amit Paschapur	Online annual progress review meeting on AINP on Soil Arthopods during July 24-27, 2020.
Dr. M. Parihar	National workshop on research methodology: concepts & applications" organised by Maharana Pratap University of Agriculture and Technology, Udaipur during June 26-27, 2020.
Dr. R.P. Yadav	Kosi river rejuvenation meeting with Kumaon Commissioner, DM and CDO at Vikas Bhawan, Almora on June 29, 2020.
Dr. S.C. Panday	Online XXVI meeting of ICAR regional committee I on June 30, 2020.
Dr. Anuradha Bhartiya	Online GEF project meeting on July 1, 2020.
Dr. Pankaj K. Mishra	Online annual review meeting of network project on AMAAS during July 1-2, 2020.
Dr. Anuradha Bhartiya	Consortium meeting of the project on agro biodiversity- diversified and sustainable food systems in the era of climate change on July 2, 2020.
Dr. D. Sharma	National webinar on journey from biofortification in food crops to including nutritional traits in varietal identification and release in pearl millet on July 9, 2020.
Dr. R.P. Yadav	Meeting at *Nagarpalika Sabhagar* regarding revival strategy of the *Bougainvillea* plant and the site with *Nagapalika* chairman Dr. R.S. Rawal, Director, GBPNIHED on July 13, 2020.
Dr. Sher Singh	Online mid-term review meeting of the NICRA project on May 21, 2020 and July 14, 2020.
Dr. D. Sharma	National webinar on understanding the variation, heterosis and their exploitation in plant breeding on July 15, 2020.

Dr. Pankaj K. Mishra	Webinar on sensitization on uploading data in KRISHI Repositories organized by ICAR-IASRI, KRISHI team on July 15, 2020.
Dr. Pankaj K. Mishra	Third webinar in the NBA-UNDP webinar Series on Biodiversity and Biological Diversity Act, 2002 on July 22, 2020.
Dr. Jitendra Kumar	Webinar on achieving land degradation neutrality organized by IASWC, IISWC and ICFRE, Dehradun during July 22-24, 2020.
Dr. D. Sharma	National webinar on CRISPR-Cas precision genome engineering on July 24, 2020.
Dr. J.P. Aditya	Farmers-Scientist interaction meeting at Lingudta, Mangalta, Bhaisiyachana on July 28, 2020.
Dr. J.K. Bisht	Online meeting with DDG, crop science and NRM, Krishi Bhawan, New Delhi July30, 2020.
Dr. Sher Singh & others	Online meeting of Directors/PC of Crop Science Institutes, July 30, 2020.
Dr. J.P. Aditya	Online training programme on Identification and management of blast diseases of rice and finger millet crops for state officials of Uttarakhand, Himachal Pradesh, Jammu and Kashmir on August 4, 2020.
Dr. R.K. Khulbe	Online *rabi* seed meeting on August 11, 2020.
Dr. Pankaj K. Mishra	Online lecture on NABL accreditation of ICAR laboratories on August 13, 2020.
Dr. R.K. Khulbe	Online CRP biofortification maize review meeting on August 18, 2020.
Dr. Rahul Dev	Webinar on mainstreaming biodiversity into agriculture sector: linkages among agro-biodiversity, nutrition, sustainable livelihoods and business opportunities organized by NBA in collaboration with M.S Swaminathan Research Foundation, Chennai on August 18, 2020.
Dr. Kushagra Joshi	Webinar on formation and effective functioning of FPO organised by ICAR-RCER, Patna on August 18, 2020.
Dr. Pankaj K. Mishra	Webinar on biological diversity act, 2002: Part II (The biological diversity rules, 2004) on August 19, 2020.
Dr. Rahul Dev	Webinar on approaches and strategies for augmenting export of bananas from India organized by ICAR-NRC- Banana on August 21, 2020.
Dr. J.K. Bisht	Online assessment meeting for promotion of Senior scientist to Principal scientist as Director representative, A.S.R.B., New Delhi on August 24, 2020.
Drs. Sher Singh and Shyam Nath	Online mid-term review meeting of the AICRP on PHET on August 25, 2020.
Dr. S.C. Panday	National webinar on abiotic stress in agriculture: geospatial characterization and management options organized by ICAR- NIASM, Baramati, Maharashtra on August 27, 2020.
Dr. Asha Kumari	Workshop on ABC in scientific writing during August 22 - September 2, 2020.
Dr. K.K. Mishra	Online AICRP Wheat and Barley group workers meet from August 24-25, 2020.
Dr. R.K. Khulbe	Online CRP Molecular Breeding Maize Review meeting on August 31, 2020.
Dr. S.C. Panday	Online presentation of poly-cement tank success story before the Honorable DDG, NRM and different centers of AICRP-IWM and PC AICRP-IWM & ICAR-IIWM on September 4, 2020.
Dr Renu Jethi	Webinar on adaptation & resilience building challenges for himalayan communities organized by GBPIHED, Almora on September 4, 2020.
Dr. R.K. Khulbe	Online CRP Molecular Breeding Maize Review meeting on September 9, 2020.
Dr. D. Sharma	Webinar on intellectual property rights: fundamentals and its importance in present context organized by UCOST, Dehradun during September 8-11 2020.
Drs. N.K. Hedau and Ganesh V. Chaudhari	National webinar on contemplative perspective on seed: conservation, quality assurance and supply system organized by IISS, Mau, on September 10, 2020.
Drs. A.R.N.S. Subbanna & Jeevan, B.	Online training on advanced bioinformatics tools and its applications in agriculture organized by ICAR-NAARM, Hyderabad during September 14-19, 2020.
Dr. J.K. Bisht	Online meeting regarding EFC of ICAR-VPKAS, Almora with DDG, Crop Science, Krishi Bhawan, New Delhi on September 17, 2020.
Dr. Renu Jethi	Webinar cum online training programme on role of nutri-garden in nutrition security of hill community organized by KVK Chinyalisaur, KVK Bageshwar and ICAR-VPKAS on September 17, 2020.
Dr. M. Choudhary	National Webinar on climate-smart integrated farming system organized by ICAR-NIASM, Baramati on September 18, 2020.

Drs. N.K. Hedau, Ganesh V. Chaudhari	Webinar on the evolution of hydroponic farming organized by Agrovision India on September 21, 2020.
Dr. Pankaj K. Mishra	Online workshop for discussing issues involved in commercialization of microbe-based technologies organized by ICAR-NBAIM, Mau, U.P. on September 23, 2020.
Drs. J.K. Bisht and R.P. Yadav	Online national annual AICRP forage crops *rabi* meeting organized by ICAR-IGFRI, Jhansi on September 22, 24 & 28, 2020.
All VPKAS scientist	Online 24th RAC Meeting of ICAR-VPKAS held on September 25, 2020.
Dr. J.K. Bisht	Online national level consultation on natural farming, organized by *Bhartiya Prakartic Krishi Padati*, New Delhi on September 29, 2020.
Drs. J.P. Aditya, Anuradha Bhartiya	Soybean field day programme organized at Maghauli on October 3, 2020.
Drs. N.K. Hedau, Ganesh V. Chaudhari	National webinar on recent advances in seed health management organized by IISS, Mau on October 5, 2020.
Dr. Anuradha Bhartiya	Webinar on DUS data management under Indo-German bilateral program organized by PPV&FRA during October 6-7, 2020.
Dr. Anuradha Bhartiya	Online soybean trial AICRP monitoring on October 9, 2020.
Drs. Anuradha Bhartiya, Kushagra Joshi and Jitendra Kumar	UN Environment-GEF Project, Technical Meeting on October 15, 2020.
All VPKAS Staff	Online Webinar on world food day and 75th anniversary of FAO organized by PM India Webcast Portal on October 16, 2020.
Drs. P.K. Mishra and B.M. Pandey	Meeting of the institute's committee for selection and assessment promotion (ICSAP) scheduled to be held at G.B. Pant Institute of Himalayan Environment (GBP-NIHE), Kosi-Katarmal, Almora on October 20, 2020.
Drs. Sher Singh, J. Kumar and Shyam Nath	Online mid-term review meeting of AICRP on plastic engineering, agriculture structure and environment control on October 21, 2020.
Drs. N.K. Hedau, Ganesh V. Chaudhari	28th meeting of central sub-committee on crop standards, notification and release of varieties for horticultural crops on October 28, 2020.
Dr. J.P. Aditya	Online AICRP Meeting on October 31, 2020.
Dr. R.K. Khulbe	Online *kharif* 2020 AICMIP monitoring of Gossaigaon centre on November 3, 2020.
Dr. Pankaj K. Mishra	Online webinar on Role of PGPR's as Bio stimulants in bio agri inputs organized by BIPA, Hyderabad and Asian PGPR society on November 04, 2020.
Drs. N.K. Hedau, Ganesh V. Chaudhari	National Webinar on Challenges and Opportunities of Vegetable Production in Warm Humid Tropics, organized by KAU & ISVS, during November 11 - 13, 2020.
Dr. R.K. Khulbe	Online IIMR-Industry meet on November 12, 2020.
Dr. Pankaj K. Mishra	Online innovation excellence indicators of public funded R&D Institutions- orientation workshop for Nodal Officers on November 14, 2020.
Dr. Kushgra Joshi	Online national workshop on psychometric scale construction technique: basic to advances organized by ICAR-NDRI, Karnal during November 24-28, 2020.
Drs. Dibakar Mahanta, Pankaj K. Mishra, Manoj Parihar and B.M. Pandey	Online XV Annual Group Meeting of All India Network Programme on Organic Farming during November 25-26, 2020.
Drs. J.P. Aditya, ARNS Subbanna, Rahul Dev, D. Sharma	Online national workshop on intellectual property management in agriculture organized by ICAR- IIAB, Ranchi on November 28, 2020.
Dr. M. Choudhary	National webinar on soil health and agriculture sustainability organized by Directorate of Research, Maharana Pratap University of Agriculture and Technology Udaipur (Rajasthan) on December 05, 2020.
Drs. N.K. Hedau, Ganesh V. Chaudhari	QRT meeting of AICRP NSP crops and ICAR Seed project, organized by IISS, Mau on December 8, 2020.
Dr. Pankaj K. Mishra	Online Webinar on Conserving Mountain Biodiversity: Addressing Climate Change, Disaster Risk Reduction through Nature Based Solutions organized jointly by Ministry of Environment, Forest & Climate Change (MoEF&CC, GOI), National Institute of Disaster Management (MHA, GOI) & International Union for Conservation of Nature (IUCN) on December 11, 2020.
Dr. Pankaj K. Mishra	Webinar on gene editing for agriculture, society & sustainable development: prospects and perspectives on December 15, 2020.

19. Trainings, Workshops, Seminars, Farmers' Days Organized

Honorable Chief Minister, Uttarakhand, Shri Trivendra Singh Rawat visited ICAR- Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora on January 3, 2020 and appreciated the work being done by the institute in the development of hill agriculture. He showed keen interest in various varieties of finger millet, maize and *Vivek Mandua* Thresher. Besides, he also distributed VL *Mandua* Thresher to 13 farmers of Almora district and spray machines & small agricultural implements to 37 farmers of Chamoli district.

Constitution Day Celebrated

On the occasion of 70th anniversary celebration of adaptation of constitution in India, a programme was organized on January 31, 2020. Constitution day celebration was held on February 22, 2020 at the institute.

Farmer-Scientist-Press Meet

A Farmer-Scientist-Press Meet on "Protection of Crops from Wild Animals" was organized on February 11, 2020 at ICAR-VPKAS, Almora. The Objective of the Meet was to demonstrate the use of Agri Canon Gun and Bioacoustic System for the protection of crops from wild animals especially monkeys, wild boars *etc.* In the inaugural remarks Dr. Arunava Pattanayak, Director, ICAR-VPKAS stressed on the importance and need of above machines for crop protection from wild animals. Dr. R. S. Tripathi, Coordinator, AINP on VPM, ICAR- CAZRI, Jodhpur told that farmers, scientists and media personnel's are the three main pillars of the society who might be responsible for collaborative development of agricultural technologies for brining success. He said that saving crops from wild animal has become a challenge. Dr. Vasudeo Rao, PS & Head, AINP on VPM, PJTSAU, Hyderabad said ICAR has taken initiative for the development of Agri Canon Gun and Bioacoustic system for the protection of wild animals and the results are quite satisfactory during testing. The demonstration of these instruments along with fruit grader developed by the institute was done in the presence of media personnel's, farmers and scientists of the Institute. On the occasion, the questions raised by media personnel and farmers were answered by the experts

Farmers-Scientists-Press Meet on Protection of Crops from Wild Animals

Demonstration of Agri Canon Gun

International Day of Yoga Organized

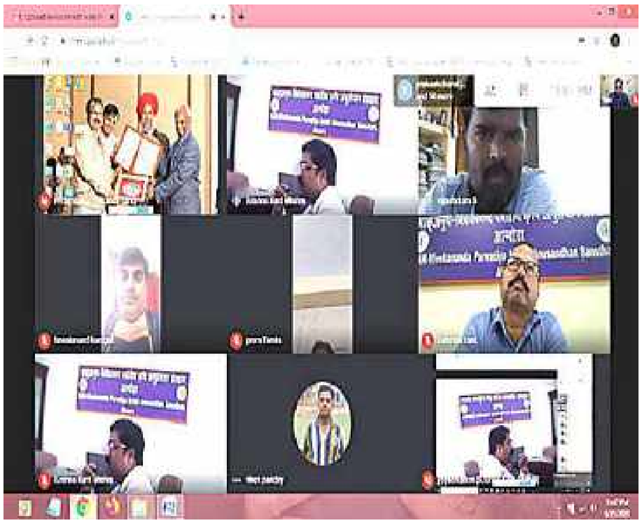
6th International Day of Yoga was organized in the morning on June 21, 2020 at ICAR-VPKAS Headquarter Almora, Experimental Farm Hawalbagh and both the *Krishi Vigyan Kendra* at Chinyalisaur and Kafligair as per the Common Yoga Protocol (CYP) developed by the Ministry of AYUSH, Government of India. The Yoga programme began with the prayer followed by loosening exercises, *Yogaasana*, *Kapaalbhaarati*, *Pranayama*, *Dhyana/Meditation* and ended with *Sankalpa* followed by *Shaanti Paatha*. All the participants pledged to continue the Yoga in future and assured to make Yoga popular among youth and children. However due to COVID19 Pandemic most of the Institute staff did Yoga practice at home along with their family members.

Training Programme on Integrated Pest and Disease Management in Major *Kharif* Crops

One day virtual online training program on integrated pest and disease management in major *kharif* crops was organized by ICAR-VPKAS, Almora on June 25, 2020. More than 30 officials from State Agriculture Department, Almora

International day of yoga at ICAR-VPKAS

joined the program. The program was inaugurated by Dr. Lakshmi Kant, Director ICAR-VPKAS. He delivered a lecture on "Pest Management in Hills: Strategies, Prospects and Limitations". Dr. K.K. Mishra, Principal Scientist emphasized the importance of crop diseases and delivered a lecture on "Major diseases of *kharif* crops and their management". Keeping in view, the recent outbreak of Locust in India and Fall army worm in Uttarakhand hills, Mr. Amit U. Paschapur, Scientist gave presentation on "Major insect-pests of *kharif* crops and their management" with emphasis on Locust management strategies in crops and Fall Army Worm management in maize. A lecture on "Nematode problems in *kharif* crops" was delivered by Mr. Ashish Kumar Singh, Scientist (Nematology).



97th Foundation Day

ICAR- Vivekananda Parvatiya Krishi Anusandhan Sansthan celebrated its 97th Foundation day using digital platform on July 4, 2020. Dr. Tilak Raj Sharma, Hon'ble Deputy Director General (Crop Science), ICAR, New Delhi was the chief guest on the occasion.

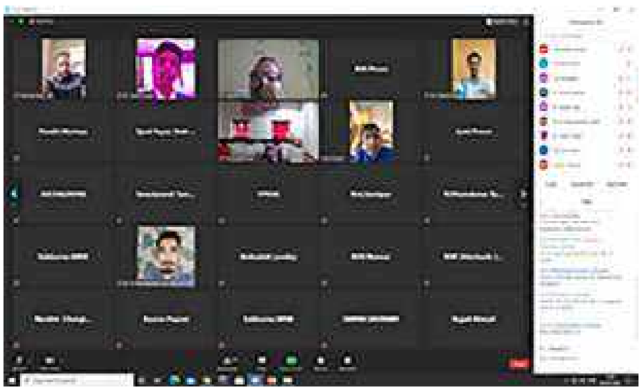
Hon'ble DDG, Dr. Sharma released the newly developed varieties, *viz.* VL *Bhat* 202 and VL Sweet Corn 2. Dr. J.P. Aditya, Scientist, Smt. Nidhi Singh, Technical Officer and Shri Harish Chandra Upadhyay, SSS were honoured for their outstanding work. Progressive farmers Smt. Preeti Bhandari, Almora and Shri Jagir Singh, Bailparav, Ramnagar were also honoured.

Training Programme on *Tuta absoluta* in Tomato: Symptoms, Identification and Management Strategies

ICAR-VPKAS organized one day online training program on *Tuta absoluta* in tomato: symptoms, identification and management strategies on July 9, 2020. More than 35 officials from State Horticulture Departments, Uttarakhand, Himanchal Pradesh, Jammu and Kashmir, Officers from different KVKs joined the programme.

Training Programme on Identification and Management of Blast Diseases of Rice and Finger Millet Crops

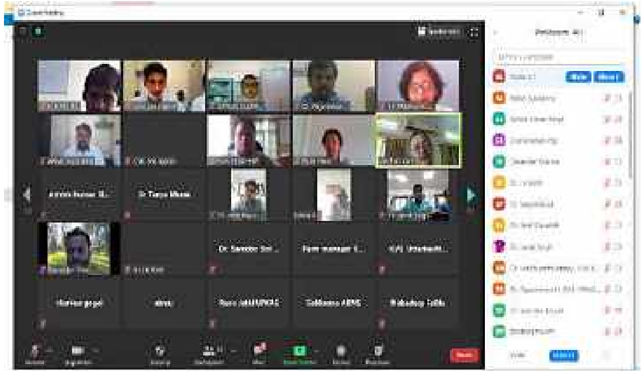
ICAR-VPKAS organized one day online training program on identification and management of blast diseases of rice and finger millet crops on August 4, 2020. More than 50 participants including state officials, SMSs from KVKs of North



Western Himalayan States and union territories (Uttarakhand, Himachal Pradesh, Jammu and Kashmir) and North Eastern Himalayan States (Meghalaya, Manipur, Mizoram, Assam, Arunanchal Pradesh, Sikkim, Tripura) joined the programme.

Training Programme on Fall Armyworm: Symptoms, Identification & Management

ICAR-VPKAS organized one-day virtual online training program on fall armyworm: symptoms, identification & management on August 7, 2020. More than 50 officials from ICAR Institutes, state departments and KVKs of North Eastern Indian Himalayan states (Meghalaya, Manipur, Mizoram, Assam, Arunanchal Pradesh, Sikkim and Tripura)



joined the programme.

Organization of Parthenium Awareness Week

ICAR-VPKAS organized 15th Parthenium Awareness Week during August 16 to 22, 2020. Farmers and general public were made aware about the ill effects of Parthenium and its management through Doordharshan, All India Radio, Newspapers, Institute website and *Krishi Vigyan Kendra*. *Gajarghas* or *Parthenium* not only creates different problems for human health and animals but also pollutes the environment and reduces productivity and severely affects biodiversity. The *Gajarghas* has spread over 35 million ha area in country. It is mainly found in empty places, uncultivated lands, industrial areas, gardens, parks, schools, residential areas and corners of roads and railway lines.




Parthenium awareness week at ICAR-VPKAS

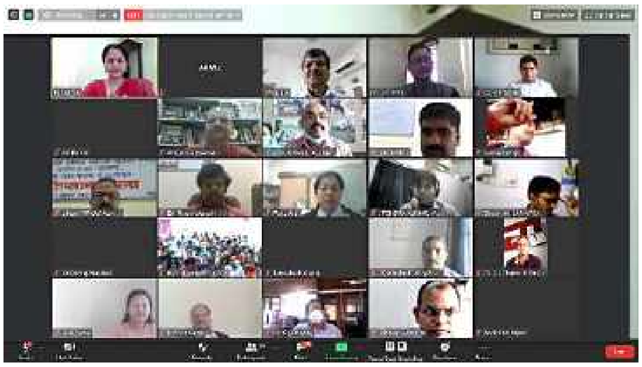
Scientist-Farmers Interaction Meet

A Scientist-farmers interaction meeting was conducted in adopted village Bhagartola, Almora on September 11, 2020. On the occasion, field monitoring of vegetable cultivation under protected condition were conducted. Various issues related to farmers organisations, marketing of vegetables, availability of quality seeds and plant protection measures were discussed. Inputs like polythenes for repair of polyhouses, kits of small tools, vegetable seeds and VL light traps were distributed to farmers.


Distibution of VL Light Trap and polythene for poly houses

Kisan Mela

The Virtual *rabi Kisan Mela* was organized in accordance with the guidelines of Covid-19 on October 21, 2020 by the institute. Chief Guest



Dr. H.S. Gupta, Former D.G., Borlaug Institute of South Asia (BISA) congratulated the Director of the Institute and farmers of the country for commendable work done during Covid-19 pandemic. Detailed information about the grant being given to farmers under various programmes was given by Chief Agriculture Officer (CAO), Chief Horticulture Officer (CHO), Chief Veterinary Officer (CVO), and District Development Manager (DDM), NABARD. The varieties, VL *Masoor* 148 and VL *Matar* 61 were also released. Besides, two publications, *viz*. income generation by improved production and post-harvest processing technology of traditional crops of hilly areas and integrated management of pinworm (*Tuta absoluta*) in tomato crop were released. The video clips on benefits of various technologies of the institute being used by various farmers in their area were presented in the form of a success story.

Vigilance Awareness Week

ICAR-VPKAS and its KVKs (Uttarkashi and Bageshwar) celebrated the Vigilance Awereness

Online poster competition under vigilance week

Week during October 27 to November 2, 2020 with the theme "*Satark Bharat, Samriddh Bharat* (Vigilant India, Prosperous India) following the Covid-19 guidelines. As per the directions received from the Central Vigilance Commission and ICAR, various activities were organized. The week started with the pledge ceremony on October 27, 2020. Different activities like, poster, extempore, essay writing competition and lecture from Eminent Scientist Dr. H.S. Gupta, Ex-DG, BISA, Ex-Vice Chancellor & Director, IARI were organized.

These activities were also tagged to the CVC social media account through institute twitter account. In a similar manner, the week was also celebrated in KVK, Uttarkashi and Bageshwar.

Republic Day Parade of Almora District

Institute participated in the 71st Republic Day Parade celebrations organized by the district administration, Almora. On the occasion the institute presented its tableau showcasing the activities and achievements of the institute in the

areas of organic farming, high yielding varieties, fodder production, water harvesting, poly-house technology, mechanization, use of solar energy, bee-keeping, mushroom production, women empowerment, food security, and others. In addition to this, efforts being made by the institute to address issues related to deforestation, monkey menace and pollution were also depicted in the tableau. The theme of this year's tableau was "पर्वतीय कृषि के विकास की कुंजी–समेकित खेती". The tableau presented by institute was adjudged the best among a total of 15 tableaus presented by the various departments and organizations working in the district, and was awarded the First Prize.

International Women Day

ICAR Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora observed International Women's Day in both its campus at Almora and Hawalbagh as well as in its KVKs at Bageshwar

and Uttarkashi. At Almora campus, a meeting was held in which women employees of the institute and women from Almora city known for their exemplary contributions in their respective fields participated. The theme given for the year 2020 **"I am Generations Equality: Realizing Women's Rights""** was elucidated. At Experimental farm, ICAR-VPKAS, Hawalbag, talks on "Achievements of women in the field of Agriculture", "Role of Women in Hill" and "Importance of Women in Hill Agriculture" were delivered by scientists.

KVKs, Kafligair and Chinyalisaur celebrated the day by organizing a *goshthi* in which *zila panchayat* members, women farmer and personnels from rural development and Women and Child development sector participated. Lectures on importance of women's role in hill agriculture were organized.

National Women Farmers day (Mahila Kisan Diwas)

National Women Farmer's day was celebrated in two villages of Almora (Kotyra village) and Bageshwar (Lakhni village) district of Uttarakhand to mark the women's role and contribution in agriculture. On the occasion, improved seeds of wheat and lentil were distributed to farm women. In order to enhance crop productivity and reduce drudgery, line sowing was demonstrated among

Soyamilk preparation

Hands on by farm women on VL *Mandua* Thresher

Demonstration of nutri-gardening

women farmers. Besides, a *Kisan Gosthi* was also organized at KVK, Bageshwar.

National Nutrition Month

As a part of National Nutrition Month celebrations, Experiential 'learning by doing' programme on 'Nutrition Gardens for diversified diets' (Theme: *Paudhon se Poshan*) was organised in Kotyura and Patiya village of Takula block in September 2020. Vegetable seed kits were distributed to 29 farm women having poor dietary diversity scores. Method demonstration on Soybean Paneer "*Tofu*" and soymilk was conducted along with knowledge on nutrition as a medium of promoting informed food choices and variety. Targeting women's workloads, millet thresher demonstration was conducted for mitigating drudgery in finger millet threshing. Thirty-three farmers including twenty-nine farm women participated in the programme.

Tofu making

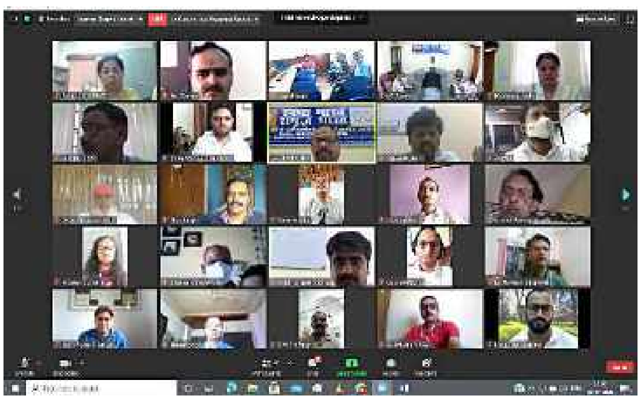
Celebration of the 150th Birth Anniversary of the Father of Nation Mahatma Gandhi

Virtual Gosthi and Conference

One week Celebration of the 150th Birth Anniversary of the Father of Nation Mahatma Gandhi was observed in ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan Almora, Uttarakhand, during September 26 to October 02, 2020. The inauguration of the celebration was started with a virtual *goshthi* on teaching of Mahatma Gandhi

and their importance in present situation. A virtual conference on "Gandhian philosophy" was also organised during this programme.

On the last day of the week, all the staff members celebrated Gandhi Jayanti after Flag Hoisting at their respective offices and later a virtual special lecture on Gandhiyan Philosohy, entitled "Ecology is the Stable Economy" was



delivered by Padma Bhushan Dr. Anil Prakash Joshi, Founder HESCO. He emphasised that there are challenges for prosperity but not for development. He emphasized the importance of Himalaya for our culture, civilization, security and prosperity. He gave a slogan, "*Mera Desh, Mera Gaon*" by which he underlined the importance of village centric development. He stressed upon place for environment and ecology in our GDP based development. The program progressed with presentation of the week long programme and the remark of Director, ICAR-VPKAS.

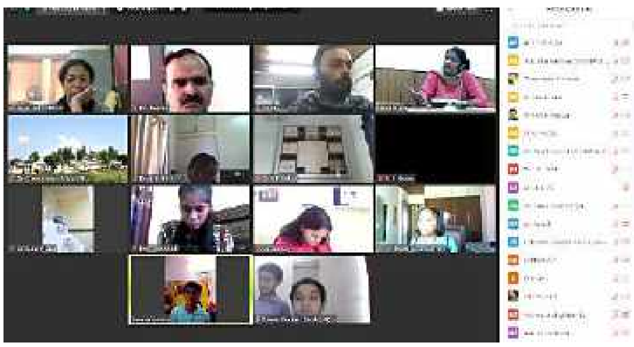
Cleanliness Campaign

A cleanliness campaign was run by the institute to clean the Experimental Farm, Hawalbagh, Almora campus and KVK Bageshwar. Staff including scientific, technical, supporting and contractual all

participated in the campaign. An attempt was made to create mass awareness about cleanliness. Garbage in the surrounding area, roads and residential colony was cleaned. Besides, water storage tank, drainage line facilities, floors, roof, grasses and garbage were also cleaned in catchment area of *Badreshwar naula* (adopted by ICAR-VPKAS for social cause) of Almora District.

Other Activities

As a part of the celebrations of 150^{th} Birth Anniversary of Mahatma Gandhi, the institute organized a Poem recitation competition for the children of the Institute staff on the theme "*Hamari Prerna: Mahatma Gandhi*" (Our Inspiration: Mahatma Gandhi) through online platform. In the programme, the children recited poems on Mahatma Gandhi, his life values and his life journey.



Exposure visit for newly recruited officer of Sashastra Seema Bal (SSB)

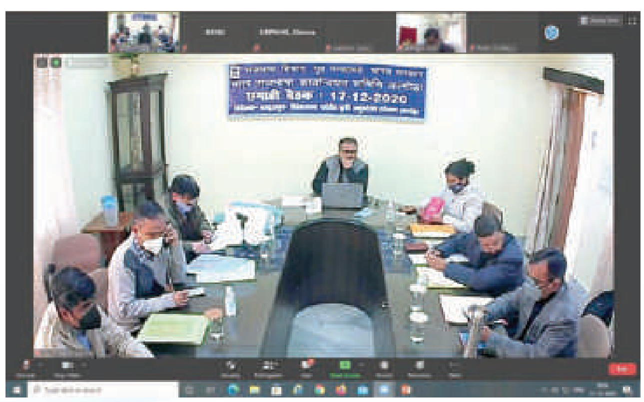
A group of 44 newly recruited officers of SSB visited Experimental Farm, Hawalbag during their Educational Tour to Almora on November 27, 2020. The group was acquainted with interventions for income enhancement, *viz.* off season vegetable cultivation, poly house technology, mushroom production technology, farm mechanization and seed processing.

20- jktHkk"kk lEcU/kh xfrfof/k;k

संस्थान में राजभाषा हिन्दी के प्रगामी प्रयोग सरकार की राजभाषा नीति के कार्यान्वयन, नियमों उपबन्धों एवं सर्वाधिक उपबन्धों के उचित अनुपालन एवं इनकी समीक्षा हेतु संस्थान राजभाषा कार्यान्वयन समिति का गठन किया गया है। समिति की प्रत्येक तिमाही में बैठक की जाती है। वर्ष 2020 के दौरान समिति की बैठके क्रमशः 30.06.2020, 30.09.2020, एवं 31.12.2020 को आयोजित को गई। राजभाषा वार्षिक कार्यक्रम की विभिन्न मदों में 'क' एवं 'ख' क्षेत्र के साथ हिन्दी पत्राचार के लिए 100 प्रतिशत का लक्ष्य रखा गया है तथा 'ग' क्षेत्र के साथ 65 प्रतिशत का लक्ष्य रखा गया है। संस्थान द्वारा 'क' क्षेत्र के साथ लगभग 75–80 प्रतिशत 'ख' क्षेत्र साथ 65–70 प्रतिशत तथा 'ग' क्षेत्र के साथ 60–65 प्रतिशत पत्र व्यवहार किया जा रहा है। राजभाषा अधिनियम की धारा 3(3) का अनुपालन सुनिश्चित किया जा रहा है। वार्षिक कार्यक्रम में नोटिंग के लिए 75 प्रतिशत का लक्ष्य रखा गया है, जबकि संस्थान द्वारा 95 प्रतिशत से अधिक नोटिंग का कार्य हिन्दी में किये जा रहे हैं। संस्थान द्वारा संचालित सभी प्रशिक्षण कार्यक्रमों में व्याख्यान हिन्दी में तैयार किए जाते हैं तथा सभी प्रशिक्षण कार्यक्रम हिन्दी में ही सम्पन्न होते है।

संस्थान में कार्यरत कार्मिकों को हिन्दी की ओर रूचि बढ़ाने एवं अपना अधिक से अधिक दैनिक कार्य हिन्दी में करने के लिए प्रोत्साहित करने हेतु 14 सितम्बर 2020 को हिन्दी दिवस एवं 14 सितम्बर से 30 सितम्बर, 2020 तक 'हिन्दी पखवाड़ा' का आयोजन वीडियों कान्फ्रेन्स (वी0सी0) के माध्यम से किया गया। हिन्दी पखवाड़े के दौरान तीन प्रतियोगितांए आयोजित की गई जिनमें (i) हिन्दी टिप्पण एवं प्रारूप लेखन प्रतियोगिता (ii) हिन्दी निबन्ध प्रतियोगिता (iii) कम्प्यूटर पर यूनीकोड में हिन्दी टंकण प्रतियोगिता आदि का आयोजन किया गया। 'हिन्दी पखवाड़े' के दौरान प्रतियोगिताओं के आयोजन के लिए संस्थान के कार्मिकों को तीन श्रेणियों/वर्गों में वर्गीकृत किया गया। वर्ग क–'क' क्षेत्र के वैज्ञानिक एवं समस्त अधिकारी, वर्ग ख–'ख' क्षेत्र एवं ग क्षेत्र के समस्त अधिकारी/कर्मचारी, वर्ग ग– सहायक वर्ग अस्थाई स्तर से सहायक एवं टी.4 तक के समस्त कार्मिक, जिसमें सभी प्रतिभागियों ने सहभागिता की। हिन्दी पखवाड़े का मुख्य कार्यक्रम सितम्बर 30, 2020 को संस्थान अल्मोड़ा में वीडियों कान्फ्रेन्स के माध्यम से एक राजभाषा संगोष्ठी पुरस्कार वितरण समारोह के रूप में किया गया। इन कार्यक्रमों में हिन्दी व अहिन्दी भाषी क्षेत्रों के कार्मिकों ने उत्साह के साथ सहभागिता की।

भारत सरकार, राजभाषा विभाग द्वारा संस्थान को नगर राजभाषा कार्यान्वयन समिति की अध्यक्षता का दायित्व दिया गया है। संस्थान द्वारा नराकास के छमाही बैठकें निर्धारित समय पर आयोजित की जाती है। वर्ष 2020 के दौरान ये बैठकें 22.07.2020 एवं 17.12.2020 को आयोजित की गयी। वर्तमान में समिति के सदस्य कार्यालयों की संख्या 32 है जिसमें केन्द्रीय सरकार के शोध संस्थान, विभाग, राष्ट्रीयकृत बैंक, उपक्रम, सशस्त्र बल आदि सम्मिलित है। संस्थान द्वारा राजभाषा विभाग द्वारा मांगी गयी सूचनाएं निर्धारित समय पर भेजी जाती है तथा राजभाषा सूचना प्रबन्धन प्रणाली के अन्तर्गत सभी सूचनाएं आन लाइन प्रेषित की जाती है। संस्थान नराकास के सभी सदस्य कार्यालयों के बीच हिन्दी को आगे बढ़ाने के लिए सामन्जस्य स्थापित करने का निरन्तर प्रयास कर रहा है।



21. Distinguished Visitors

❖ Shri Tivendra Rawat, Hon'ble Chief Minister of Uttarakhand visited ICAR-VPKAS, Almora on Jan 03, 2020.

❖ Shri. Pradeep Pant, District & Session Judge, Almora visited Experimental Farm, Hawalbag, ICAR-VPKAS on May 17, 2020.

❖ Dr. H. S. Gupta, Ex Director General, BISA, Ex-Vice Chancellor & Director, IARI New Delhi visited ICAR-VPKAS, Almora on October 27, 2020.

❖ Shri Ajay Tamata, Hon'ble Union Minister of State for Textiles and Member of Parliament (MP) visited ICAR-VPKAS, Almora on July 03, 2020.

❖ Dr. R. S. Tripathi, Coordinator, AINP on VPM, ICAR- CAZRI, Jodhpur visited ICAR-VPKAS, Almora on November 11, 2020.

❖ Dr. Vasudeo Rao, PS & Head, AINP on VPM, PJTSAU, Hyderabad visited ICAR-VPKAS, Almora on November 11, 2020.

22. Institute Personnel

Dr. A. Pattanayak, Director (upto 17.02.2020)

Dr. Lakshmi Kant Director (*w.e.f.,* 18.02.2020)

Crop Improvement Division

Dr. Lakshmi Kant, Principal Scientist (Plant Breeding) & Head

Dr. Om Vir Singh Pr. Scientist (Genetic & Plant Breeding)

Dr. N.K. Hedau, Principal Scientist (Horticulture-Vegetable Science)

Dr. R.K. Khulbe, Principal Scientist (Plant Breeding)

Dr. Jay Prakash Aditya, Sr. Scientist (Plant Breeding)

Dr. D.C. Joshi, Sr. Scientist (Plant Breeding)

Dr. Anuradha Bhartiya, Scientist (Plant Breeding)

Dr. Ramesh Singh Pal, Scientist (Biochemistry)

Dr. Rahul Dev, Scientist (Economic Botany & Plant Genetic Resources)

Dr. Rakesh Bhowmick, Scientist (Agricultural Biotechnology)

Dr. Chaudhari G. Vasudeo, Scientist (Vegetable Science)

Dr. Hanuman Ram, Scientist (Vegetable Science) (upto August 7, 2020)

Dr. Navin Chander Gahtyari, Scientist (Genetic & Plant Breeding)

Dr. Devender Sharma, Scientist (Genetic & Plant Breeding)

Dr. Asha Kumari, Scientist (Plant Physiology)

Mr. Sougata Bhattacharjee, Scientist (Agri. Biotechnology)

Mr. Mahendra Bhinda, Scientist (Genetic & Plant Breeding)

Crop Production Division

Dr. J.K. Bisht, Principal Scientist (Agronomy) & I/c Head

Dr. S.C. Panday, Principal Scientist (Soil Science)

Dr. P.K. Mishra, Principal Scientist (Agricultural Microbiology)

Dr. B.M. Pandey, Principal Scientist (Agronomy)

Dr. Sher Singh, Principal Scientist (Agronomy)

Dr. Dibakar Mahanta, Sr. Scientist (Agronomy) (upto December 26, 2020)

Dr. Ram Prakash Yadav, Scientist (Agroforestry)

Mr. Tilak Mondal, Scientist (Agricultural Chemistry) *(on study leave)*

Dr. Vijay Singh Meena, Scientist (Soil Science) (On deputation *w.e.f.* May 26, 2020)

Mr. Mahipal Chaudhary, Scientist (Soil Science) *(on study leave)*

Er. Shyam Nath, Scientist (Farm Machinery & Power)

Dr. Jitendra Kumar, Scientist (Soil and Water Conservation Engineering)

Dr. Manoj Parihar (Soil Science)

Mr. Rajendra Prasad Meena, Scientist (Agronomy) *(on study leave)*

Er. Utkarsh Kumar, Scientist (Land & Water Management Engineering) *(on study leave)*

Dr. Priyanka Khati, Scientist (Agricultural Microbiology)

Crop Protection Section

Dr. K.K. Mishra, Principal Scientist (Plant Pathology) & I/c

Dr. A.R.N.S. Subbanna, Scientist (Agricultural Entomology)

Dr. Rajashekara, H., Scientist (Plant Pathology)

Mr. Amit Umesh Paschapur, Scientist (Agricultural Entomology)

Mr. Ashish Kumar Singh, Scientist (Nematology)

Mr. Jeevan B., Scientist (Plant Pathology)

Mr. Chandan Maharana, Scientist (Plant Pathology)

Social Science Section

Dr. Brij Mohan Pandey, Principal Scientist (Agronomy) & I/c

Dr. Renu Jethi, Sr. Scientist (Home Science Extension)

Dr. Kushagra Joshi, Scientist (Home Science/FRM)

Coordinators/ In-charge

Library

Dr. P.K. Mishra

AKMU

Dr. Renu Jethi

PME Cell

Dr. J.K. Bisht, In-charge

Farm

Dr. N.K. Hedau

Drs. N.K. Hedau & Sher Singh (Mukteshwar)

Vehicle

Mr. A.K. Joshi, Administrative Officer (upto 30.06.2020)

Mr. Lalit Mohan Tewari, Asstt. Administrative Officer (*w.e.f.* 01.07.2020)

Guest House

Dr. N.K. Hedau

Dr. Dibakar Mahanta (Hawalbag)

Shri Sanjay Kumar Arya, (Almora)

Maintenance

Mr. A.K. Joshi, Administrative Officer (upto 30.06.2020)

Mr. Lalit Mohan Tewari, Asstt. Administrative Officer (*w.e.f.* 01.07.2020)

Krishi Samridhi Radio Programme

Dr. Kushagra Joshi

Technical Officers

Shri. S.K. Arya

Shri. D.S. Gosai

Shri. M.C. Pant

Shri. D.C. Mishra

Dr. G.S. Bisht

Shri. D.S. Panchpal

Shri. N.K. Pathak

Smt. Renu Sanwal

Shri. O.P. Vidhyarthi

Shri. Daya Shankar

Shri. C.S. Kanwal

Shri. J.K. Arya

Shri. Narayan Ram

Administration and Finance

Senior Administrative Officers

Mr. R.S. Negi (*w.e.f.* 14.08.2020)

Administrative Officers

Mr. A.K. Joshi (upto 30.06.2020)

Assistant Administrative Officers

Mrs. Radhika Arya

Mr. Lalit Mohan Tewari

Finance & Accounts Officer

Mr. B.C. Pandey, FAO

Stores

Mr. A.K. Joshi (upto 30.06.2020)

Shri Sanjay Kumar Arya (*w.e.f.* 01.07.2020)

Managerial Staff at KVK, Chinyalisaur

Dr. Pankaj Nautiyal, CTO/ T-9, Horticulture

Ms. Manisha, ACTO, Home Science (on study leave *w.e.f.* 08.01.2019 to 07.01.2021)

Dr. Gaurav Papnai, ACTO, Agril. Extension

Managerial Staff at KVK, Bageshwar

Dr. Kamal Kumar Pandey, CTO/ T-9, Horticulture

Dr. N.K. Singh, ACTO, Veterinary Science (on study leave *w.e.f.,* 02.09.2019 to 01.09.2022)

Dr. H.C. Joshi, ACTO, Plant Protection

Shri. Medni Pratap Singh, Farm Manager/T-5

Smt. Nidhi Singh, Prog. Asst. (Lab Technician) to T-5

New Colleagues

- Dr. Omvir Singh, Pr. Scientist (Genetics & Plant Breeding) on 01.01.2020
- Mr. Chandan Maharana, Scientist (Plant Pathology) on 04.04.2020
- Mr. Mahendar Singh Bhinda, Scientist (Genetics & Plant Breeding) on 04.04.2020
- Mr. Sougata Bhattacharjee, Scientist (Agril. Biotechnology) on 04.04.2020
- Mr. R.S. Negi, Senior Administrative Officer on 14.08.2020

Retirement

- Shri Chandan Singh, Skilled Supporting Staff on 19.02.2020
- Shri A.K. Joshi, Administrative Officer on 30.06.2020

- Smt. Jibuli Devi, Skilled Supporting Staff on 30.09.2020

Transfer

- Dr. Hanuman Ram, Scientist to CIAE, Bikaner on 07.08.2020
- Dr. Dibakar Mahanta, Sr. Scientist to IARI, New Delhi on 26.12.2020

Resignation

- Shri. Deenbandhu Gain, Technician on 30.11.2020

Deputation

- Dr. Vijay Singh Meena, Scientist *w.e.f.* 26.05.2020

Promotion

- Dr. Dibakar Mahanta, Scientist to Sr. Scientist (RGP 8000/-) *w.e.f.* 01.07.2017.
- Dr. Kushagra Joshi, Scientist to Scientist (RGP 7000/-) *w.e.f.* 01.01.2017
- Dr. Rajashekara, H. Scientist to Scientist (RGP 7000/-) *w.e.f.* 01.01.2018
- Dr. Vijay Singh Meena, Scientist to Scientist (RGP 7000/-) *w.e.f.* 01.01.2018
- Dr. Renu Jethi, Scientist to Sr. Scientist (RGP 8000/-) *w.e.f.* 15.12.2018.
- Dr. Jay Prakash Aditya, Scientist to Sr. Scientist (RGP 8000/-) *w.e.f.* 17.01.2019.
- Mr. Atheequlla, G.A., Scientist to Scientist (Research level 11) *w.e.f.* 15.09.2016
- Dr. Pankaj Nautiyal, Subject Matter Specialist (T-9) w.e.f. 22.08.2019
- Shri Harish Chandra Pandey, Driver/ T-3 w.e.f. 28.01.2019
- Shri Birendra Puri Goswami, Driver/ T-3 w.e.f. 28.01.2019
- Shri Har Singh, SSS to Lower Division Clerk *w.e.f.* 08.04.2019
- Shri Vishnu Dutt Pandey, SSS to Lower Division Clerk *w.e.f.* 08.04.2019
- Shri Anand Singh Adhikari, SSS to Lower Division Clerk *w.e.f.* 08.04.2019
- Shri Khyali Ram, Lower Division Clerk w.e.f. 09.10.2019
- Smt. Janki Mehta, SSS to LDC *w.e.f.* 23.01.2020

Study Leave

- Ms. Manisha, ACTO, Home Science (on study leave *w.e.f.* 08.01.2019 to 07.01.2021)
- Dr. N.K. Singh, ACTO, Veterinary Science (on study leave *w.e.f.* 02.09.2019 to 01.09.2022)
- Mr. Utkarsh Kumar, Scientist, Land & Water Management Engineering (on study leave *w.e.f.* 28.12.2020 to 27.12.2023)
- Mr. R.P. Meena, Scientist, Agronomy (on study leave *w.e.f.* 24.10.2020 to 23.04.2022)

23. Human Resource Development (HRD)

For

ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora-263601, Uttarakhand, India

(2020)

A. Physical targets and achievements

S. No.	Category	Total No. of Employees	No. of trainings planned for 2020 as per ATP	No. of employees undergone training during Jan-June 2020	No. of employees undergone training during July to December 2020	Total no. of employees undergone training during January to December 2020	% realization of trainings planned during 2020
1	2	3	4	5	6	Col. 5 + 6 =7	Col. 7*100/ Col. 4 = 8
1	Scientist	41	04	05	11	16	400.0
2	Technical	27	03	01	06	07	233.0
3	Administrative & Finance	18	03	00	03	03	100.0
4	SSS	39	00	00	00	00	0.00
	Total	**124**	**10**	**06**	**20**	**26**	**260.0**

B. Financial targets and achievements (All employees)

S. No.	RE 2020 for HRD (Rs.)	Actual Expenditure up to December 31, 2020 for HRD (Rs.)	% Utilization of allotted budget
1	2	3	3*100/2=4
	5,00,000.0	**Nil**	**0.00**

*** The allocated budget was not utilized due to pandemic Covid-19 situation and most of the trainings were attended online.**

C. Number of trainings organized for various categories of ICAR employees including winter/summer schools and short-term trainings

S. No.	Category	No. of trainings organized during January to June 2020	No. of trainings organized during July to December 2020	Total no. of trainings organized during January to December 2020	No. of participants (Only ICAR employees)		
					Organizing Institute	Other ICAR Institutes	Total
1	2	3	4	Col. 3+4=5	6	7	6+7=8
1	Scientist	0	0	0	0	0	0
2	Technical	0	0	0	0	0	0
3	Administrative & Finance	0	0	0	0	0	0
4	SSS	0	00	00	0	0	0
	Total	**0**	**00**	00	**0**	**0**	**0**

केसर की वैज्ञानिक खेती
ICAR-VPKAS Extension Leaflet (126/2020)
Health Boosting Nutri Crops of Uttarakhand Himalayas
gef
UN
Bioversity
CIAT
ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan
(An ISO 9001-2008 Certified Institute)
Almora - 263 601 (Uttarakhand)
(2020)
Toll free krishak helpline: 1800 180 2311
Contact Timing : Every working day (10:00 am - 5:00 pm)

भाकृअनुप
ICAR

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch