PREFACE

I feel privileged to present the Research Highlights of CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur for the year 2006-2007. The concerted research efforts are being made at the main campus Palampur and our satellite Research Centres and Stations throughout the State of Himachal Pradesh. The main areas of research include Agriculture, Veterinary and Animal Sciences, Home Science and Basic Sciences.

The priority strategic research issues to be addressed keeping in view the problem-oriented agenda of the hill farmers in increasing the production and productivity of agricultural crops are being tackled by the strenuous efforts of the scientists of the University. The research efforts were made to face challenges of Intellectual Property Rights and WTO, and to find solution through new production technologies to improve the socio-economic condition of the hill farmers. Inspite of financial constraints, our scientists could bag a large number of projects from various funding agencies and kept the pace of research in energetic form.

I express my deep sense of gratitude to the Hon’ble Vice-Chancellor, Dr Tej Partap for his inspiring and dynamic leadership to accomplish various achievements. I also express my deep gratitude to former Vice-Chancellor, Dr D.S. Rathore for his constructive criticism and fruitful guidance during his leadership. I extend my sincere thanks to all the Statutory Officers especially the Deans of the four constituent colleges, Dean Postgraduate Studies and Director Extension Education for supporting various research programmes at main campus as well as at outstations. I would like to place on record the financial help rendered by different funding agencies like ICAR, DST, DBT, GBPIHED, NOVODB, NMPB, Ministry of Environment & Forests, NCOF (GOI), DRDA and Department of Agriculture (H.P. Govt.), FAI and DAE for carrying out various research activities. It would not have been possible for me to compile and present this document without the active cooperation of all the Associate Directors, Scientist-Incharges, Heads of the departments, scientists and teachers of the University. I am highly thankful to all of them for their active cooperation. The help rendered by Dr S.P. Dixit, Professor (Soil Science), Sh. P.C. Kaundal (ADO Res.), Sh. B.S. Rana (STA), Sh. Sat Pal (PA) and Sh. Ramesh Kumar (PA) of the Directorate of Research is duly acknowledged.

I appreciate the efforts of Dr P.C. Sharma, Assistant Professor (Entomology) for his concerted efforts in compiling, editing and printing of this document.

(Satish C. Sharma)
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Executive Summary</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Detailed Research Achievements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agriculture</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crop Improvement</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Crop Management</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Crop Protection</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Mushrooms and Apiculture</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Biotechnology</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Agricultural Engineering</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Seed Production</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Tea Husbandry and Technology</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Agroforestry and Environment</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Horticulture</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Social Sciences</td>
<td>38</td>
</tr>
<tr>
<td>3.</td>
<td>Home Science</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Food Science and Nutrition</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Family Resource Management</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Human Development</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Textile and Apparel Designing</td>
<td>42</td>
</tr>
<tr>
<td>4.</td>
<td>Basic Sciences</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Microbiology</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Botany and Zoology</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Plant Physiology</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Chemistry and Biochemistry</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Geo-informatics Research</td>
<td>45</td>
</tr>
<tr>
<td>5.</td>
<td>Veterinary and Animal Sciences</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Animal Breeding, Genetics and Biostatistics</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Animal Nutrition</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Veterinary Microbiology</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Veterinary Physiology</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Veterinary Pharmacology and Toxicology</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Veterinary Parasitology</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Veterinary Pathology</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Veterinary Clinical Medicine, Ethics and Jurisprudence</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Veterinary Surgery and Radiology</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Animal Reproduction, Gynaeology and Obstetrics</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Veterinary Anatomy and Histology</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Fisheries</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Livestock Farm</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Livestock Products Technology</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Veterinary and Animal Husbandry Extension</td>
<td>53</td>
</tr>
<tr>
<td>6.</td>
<td>Annexure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Research Projects in Operation</td>
<td>Annexure I 54</td>
</tr>
<tr>
<td></td>
<td>Important Events</td>
<td>Annexure II 59</td>
</tr>
<tr>
<td></td>
<td>Awards and Honours</td>
<td>Annexure III 60</td>
</tr>
<tr>
<td></td>
<td>Visits Abroad</td>
<td>Annexure IV 62</td>
</tr>
<tr>
<td></td>
<td>Research Publications</td>
<td>Annexure V 64</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

I. AGRICULTURE

A. Crop Improvement

Rice
- Varundhan, a new variety of rice has been released by the State Variety Release Committee for cultivation under transplanted irrigated conditions in hilly areas of HP (1000 m amsl). It is a red grain variety with average yield of 3210 kg/ha, giving an increase of 96.9 per cent over local variety Jattoo (1630 kg/ha) and 77.3 per cent increase over Naggar Dhan (1810 kg/ha).
- Hybrid Rice (HRI-152) from Bayer Crop Science with an average yield of 7080 kg/ha having field resistance to rice blast in mid hills and with superiority in grain yield of 61 per cent over HPR-2143 and 27 per cent over HPR-2344, has been recommended for cultivation under mid hills below 1000 m altitude for assured irrigated areas of HP.

Maize
- On the basis of multilocational evaluation of maize hybrids of private companies during Kharif 2006, Bisco- 855 (7026 kg/ha), S-621 (7001 kg/ha), HM-105 (6803 kg/ha), Bisco-844 (6795 kg/ha) and X-640 (6792 kg/ha) were top five best hybrids and were recommended for cultivation within the State.
- DKI-9205 was identified as a stable source of resistance against ESR as it showed immune reaction during the last three years of testing. Among medium maturing inbreds, DKI-9770 was categorized highly resistant (<10% incidence) and thus identified to be stable source of resistance on the basis of three years of screening.
- In specialty corn types, HQPM-1 and FQH-4567 of Quality Protein Maize, Win Orange-a sweet corn variety and Amber-a Pop corn variety were identified for Zone-I.

Wheat and Barley
- Three wheat varieties HPW-211, Shivalik (HS-420) and VL Gehun-829 have been released by SVRC for cultivation in H.P. under low hills (timely sown irrigated) and mid-hill conditions (late sown) and low and mid-hill conditions (early sown), respectively. HPW-211 is a high yielding variety (3470 kg/ha) having tolerance to Karnal bunt and genetic diversity for resistance to brown rust, yellow rust and powdery mildew. HS-420 is a high yielding wheat variety (2700 kg/ha) having high degree of resistance against stripe and leaf rust. VL-829 is a high yielding variety (2500-3000 kg/ha) having high degree of resistance to stripe rust, leaf rust and loose smut.
- HPW-251 (2309 kg/ha) has been found to be promising under early sown conditions and is in the final year of testing exhibiting significantly higher yield than all the check varieties in early sown advance varietal trial.
- Two entries, BHS-365 and BHS-410 were observed to be superior as dual purpose (grain & fodder) varieties of barley.

Pulses
- Himachal Mash-1(UPU 00-31), a new variety of mash, has been recently recommended for cultivation in submontane low hills sub-tropical zone of HP. This variety has an average yield of 1400-1600 kg/ha with resistance to anthracnose, leaf spot, viral disease and tolerance to Cercospora leaf blight.
- Summer moong, SML-668 has been released for cultivation in zone-I. The variety is having an average yield of 1270 kg/ha as compared to the variety Pusa Baisakhi (940 kg/ha) and SML-134 (950 kg/ha). It matures in about 75-85 days.
- Chickpea genotype GPF-2 has been found to be high yielding and resistant to Ascochyta blight. On farmers’ field, this genotype has performed very well. C-71, C-61, C-121, C-123 and G-127 gave significantly higher grain yield as compared to the check ICCV-90201 at Dhaulakuan.
- A white seeded dual purpose variety of cowpea, Himachal Lobia-2 (C-519) has been recommended for cultivation in
submontane low hills sub-tropical zone of HP. It has average green pod yield of 4500-5000 kg/ha with tender green pods less beany flavour and having resistance to Cercospora leaf spot and mosaic.

**Oilseeds**

- BCRS-17 of Karan rai recorded the highest seed yield (1213 kg/ha) followed by HC-9605 (958 kg/ha) in comparison to the best national checks Kiran (859 kg/ha) and local check Jayanti (745 kg/ha).

- Strain HPBS-1 of brown sarson appeared as significantly top seed yielder (1296 kg/ha) followed by KDH-BS-6 and 02-KLM-6 in comparison to the best local check KBS-3 (1059 kg/ha).

- In gobhi sarson, ONK-1 gave significantly higher yield (3670 kg/ha) than the check variety, Neelam (2220 kg/ha) at Bajaura. In AVT-1+ AVT-II trial, the strain ONK-1 of gobhi sarson from Kangra centre appeared as significantly highest seed yielder (1709 kg/ha) in comparison to the best zonal check RL-1359 (1331 kg/ha).

- Out of 13 genotypes of soybean tested, the lines AVT-1 8 T H 388 x NRC-2 (1999 kg/ha), P1-1-1-1 PK 1053 x P7-1-1 (1944 kg/ha) and P 69-3-1-1-1 PK 1053 x Himso-107 (1930 kg/ha) performed better in respect of disease as well as yield at Sundernagar.

**Fodder Crops**

- Among fodder crops, hybrid entry PNB-93 of napier-bajra, S-17 of Setaria, BL-180 of berseem and two varieties of oats viz., JHO-99-1 (single cut), RO-19 (multi cut) and PWC-3 of white clover were observed to be superior.

**Underutilized Crops**

- Buckwheat variety (Sangla B-1) has been released by the Central Variety Release Committee for zone-IV of Himachal Pradesh.

- Among 90 genotypes of buckwheat evaluated, Sangla-1, EC 216629, EC 272734-1 and IC16-2 performed better with respect to yield and yield contributing traits.

**Vegetables**

- In garden pea, Punjab-89 variety has been observed to be promising with respect to yield, long green pods, number of seeds/pod and powdery mildew resistance. In addition, line VP-233 gave significantly highest pod yield.

- Among the cauliflower varieties, Hybrid Radha gave a yield of 25.9 t/ha when compared with Palam Uphar (14.80 t/ha) at Dhaulakuan.

- In tomato, bacterial wilt resistant genotype Hawaii-7998 performed better than the checks in the All India coordinated varietal trials. Bacterial wilt resistant tomato genotypes namely, Megha Tomato-2, BL-333-3, Hawaii-7998 and H-62 were found promising for fruit yield.

- Lines EC-464107, EC-464108 and PBC-631 of bell pepper were found resistant to bacterial wilt and exhibited more than 90 per cent plant survival.

- Line MFB-2 of Frenchbean gave highest yield having straight pods. The genotypes viz., VLFB-2003, DPFBBBS-1, Arka Anoop and IIHR-909 were found promising with respect to green pod yield and stringless pod quality.

- In brinjal, highest marketable yield (28.09 t/ha) was recorded in hybrid Sandhya followed by Arka Keshav (26.01 t/ha) at Palampur. Like previous year, Arka Nidhi (resistant check) recorded the minimum incidence of bacterial wilt.

- Okra line IC-90269 gave the highest fruit yield followed by IC-32398 and IC-31850. Line 169469 was found promising for shorter inter-nodal length.

**Spices**

- Genotypes JKC-101 and Anugrah of chilli exhibited resistance against bacterial wilt.

- Over the years, DKGD variety of ginger has recorded the highest yield of 13.3 t/ha.

- In common methi, the DPF-205 gave highest green yield (8.0 t/ha) and seed yield (16.0 t/ha) whereas Pusa Kasuri gave
highest fresh yield of 9.5 t/ha and seed yield of 6.0 t/ha.

**B. Crop Management**

**Cropping systems**

- Under mid hill conditions of Himachal Pradesh, babycorn + frenchbean (pole)-pea-summer squash, babycorn + asparagus bean-pea-summer squash, okra-cauliflower-frenchbean (bush type) and okra-radish-onion were more productive and remunerative sequences than maize-wheat sequence.

- At Kangra, maize-green frenchbean-potato gave highest system productivity of 29.3 and 29.2 t/ha and net returns Rs. 2, 68,985 and 2, 43,100/ha under inorganic and integrated nutrient management system, respectively. Under organo-management system, highest productivity (20.8 t/ha) and net returns (Rs. 51,032) were in maize-frenchbean-garlic cropping system.

- In Lahaul valley, capsicum and tomato were highly suitable cash crops compared to existing ones in mono-cropping system whereas, pea-summer squash and pea + carrot were the better options under double/intercropping systems.

**Fertility management**

- In a long-term fertility experiment conducted at Badhiarkhar farm, significantly highest rice equivalent yield was obtained when 50% NPK (through fertilizers) + 50% N (through FYM) was applied to rice and 100% NPK (through fertilizers) to wheat in rice-wheat cropping system.

- The site-specific nutrient management experiments on maize were conducted at Palampur, Bajaura and Dhaulakuan during Kharif-2006 to increase crop yield through efficient nutrient management. The maximum productivity of 4200, 6900 and 3300 kg/ha maize was recorded at Palampur, Bajaura and Dhaulakuan with the application of 150% NPK + 20 kg/ha ZnSO$_4$.

- At Malan, application of 50 % NPK + FYM @ 5t/ha 15 days before sowing with or without *Azotobacter* being at par with 50 % NPK + FYM 5 t/ha incorporated just before sowing resulted in higher yield of upland rice over farmers’ practice.

- In pea + carrot intercropping system, application of either 2.5 t FYM/ha + *Rhizobium* or 5 t FYM /ha gave significantly higher pea equivalent yield. The former treatment also gave the highest net returns of Rs. 1,41,633/ha in Lahaul valley.

- Application of 20 t vermicompost/ha + 100% NPK + biofertilizer gave maximum yield in okra (4.8 t/ha), cauliflower (20.7 t/ha) and frenchbean (12.1 t/ha) as compared with recommended practice.

**Forage and grassland management**

- Application of biofertilizers i.e. *Azotobacter* to setaria and *Rhizobium* to white clover resulted in significant improvement in herbage yield of setaria + white clover cropping system over control.

**Agricultural Meteorology**

- A significant rise of 1°C (1.5°C in Rabi and 0.4°C in Kharif) in annual mean temperature was observed in Palampur region. Rainfall showed an unprecedented decrease of 1365 mm annually (938 mm in Kharif alone) over the past 31 years upto 2005. Evaporation has decreased at 2.6 mm/annum and RH is increased at 0.5 mm annually.

**C. Crop Protection**

**Insect-pests**

- In paddy, for the control of leaf folder, hispa and whorl maggot, chlorpyriphos 10G (1000 g a.i./ha) and carbofuran 3G (1000 g a.i./ha) were found effective. Among the foliar applications, monocrotophos (500 g a.i./ha) was the most effective against rice hispa and whorl maggot whereas spinoxad 45 SC (56 g a.i./ha) was found effective for the control of leaf folder.
• For the management of whitegrubs in pea in the dry temperate areas of the state, seed treatment with thiamethoxam 70 WS (2 g/kg) resulted in minimum plant mortality (7.96 %).
• Endosulfan (0.05%), lambda-cyhalothrin (0.004%), and \textit{Trichogramma bactrae} @ 25000 adults/ ha + Econeem (3 ml/l) proved effective against \textit{Plutella xylostella} infesting cole crops.
• A new isolate of Pb GV has been found infesting \textit{Pieris brassicae} in Kangra area. Two more baculoviruses have been isolated from \textit{Agrotis ipsilon} and \textit{Plusia} species.
• For organic vegetable production, 10% aqueous leaf extract of ‘Karvi’ and ‘Bhang’ (\textit{Cannabis sativa}), were found to be the most effective and economical to control tomato fruit borer.
• Against potato tuber moth, spinosad (0.0024%) was found effective under field conditions. In potato stores, spinosad @ 50 ml/ ton of tubers also proved effective up to three months of storage.
• More than 45 polyhouses in Himachal Pradesh were surveyed for nematode infestation. Root knot nematode was found to be the most devastating and has resulted in failure of carnation crop in some polyhouses in district Bilaspur. In paddy fields, the losses due to root knot nematodes, \textit{Meloidogyne graminicola} were estimated to the extent of 8 per cent.

\textbf{Diseases}

• Among six bio-pesticides evaluated against rice blast, four applications of bio-pesticide Trichozen-T when applied to soil @ 5 kg/ha was found most effective against leaf blast where as biotos @ 2.5 ml/litre of water was observed as most effective against neck blast.
• Two sprays of Ecoderma (\textit{T. viride}) @ 5g/litre at flag leaf stage and 50 % ear head emergence stage gave 89 per cent control of Karnal bunt of wheat. However, one spray of Ecoderma followed by another spray of Tilt resulted incomplete control of the disease.
• Sudden wilt of sponge gourd is the most serious disease causing even 100 per cent loss in some cases particularly in Kangra, Hamirpur, Una and Bilaspur districts of Himachal Pradesh. One spray of Sevin (2g/litre) immediately after germination or after transplanting seedlings from polytubes followed by regular sprays of Roket (1 ml / lit) + Bacterinashak (0.3 g / lit) followed by endosulfan (2 ml / lit) + Bacterinashak (0.3 g / lit) and Sevin (2 g / lit) + Bacterinashak (0.3 g / lit) starting from the initiation of flowering at 15 days interval managed the disease by 60-80 per cent.
• Raxil @ 2 g followed by carbendazim @ 2.5 g and F-100 @ 3.5 g/kg seed were found effective in managing root rot/wilt complex of pea and also improved the yield. Seed treatment of pea with bio-control agent \textit{T. harzianum} @ 5g/kg and one foliar spray of Bavistin @ 0.1% gave significant control of root rot complex and foliar diseases of pea.
• Three sprays of fungicide Score 25EC @ 0.05% and Kavach @ 0.25% were highly effective in reducing the incidence of Phyllosticta leaf spot and increasing the yield of ginger.
• Four common bean cultivars possessing resistance against different strains of BCMV have a single dominant (Hans & Contender) and recessive (KRC 22 & KRC-4) resistance gene.

\textbf{Weeds}

• Tank mix application of clodinofop 60 g + carfentrazone 10 g/ha or clodinofop 60 g + metsulfuron methyl 3 g/ha and sequential application of clodinofop followed by (1b) 2,4-D or metsulfuron or carfentrazone were equally effective to control weeds and increase grain yield of wheat.
• For control of weeds in raised seed bed planted blackgram with particular reference to \textit{Ageratum}, application of metolachlor 1.5 kg/ha (pre) or imazethapyr 0.100 kg/ha resulted in effective control of weeds and increase in seed yield.
• Drum seeding of rice in combination with cyhalofopbutyl 90 g/ha (20 DAS) resulted in higher grain yield by effective control of weeds over broadcast method in integration with butachlor 1.5 kg/ha.
• Post emergence application of clodinofop at 80 g/ha + 2, 4-D @ 0.5 kg/ha resulted in significant reduction in weed dry weight and weed count and highest yield of linseed.

D. Mushrooms and Apiculture
• Out of 188 fleshy fungi mother cultures five culture extracts have been found to possess anti-dementia activity. Culture No. F HKV-IHB 652 MB has been found to be active for the anti-dementia and anti-parkinsonian activity whereas culture No. F HKV-IHB 658 MB has been found to possess activity against dementia, depression and anxiety in *in vitro* screening.
• More than 35 specimens of wild and edible macro fungi from Lahaul valley were collected and identified for the first time belonging to species of *Lactarius, Laetiporus, Laccaria, Stropharia, Marasmius, Cortinarius, Ramaria, Russula* and *Strobilomyces*.
• Fumigation of *A. mellifera* colonies with formic acid 85 % @ 3-5 ml/colony/day for 21 days and oxalic acid 3% sprayed on bees @ 5ml/colony thrice at an interval of 10 days were found effective for *Varroa* management. Under the programme on Task Force on beekeeping, 5 farmers adopted beekeeping and 3 are functioning as migratory beekeepers.

E. Biotechnology
• Bioinformatics tools were used to identify Fe and Zn transporter candidate genes. A total of 22 SSR loci were identified in the candidate gene sequences for zinc and iron transporters. Five of the SSR markers, viz., AZM5_16199, AZM5_13741, AZM5_91540, AZM5_89415, AZM5_17530 showed polymorphism.
• For pyramiding of powdery mildew resistance genes in pea, BC$_2$F$_1$ and BC$_3$F$_1$ of progenies of crosses Lincoln x JI 2302 (er1), Lincoln x JI 1559 (er2) and Lincoln x JI 2480 (er2) carrying powdery mildew resistance genes *er1* and *er2* were generated through marker assisted selection using *er1* and *er2* linked markers. The selfed seed from BC$_3$F$_1$ plants will be used to select homozygous carriers of *er1* and *er2*.
• *Fusarium oxysporum* and *F. solani* were found to be the predominant fungi associated with wilt/root rot in Lahaul valley.
• Molecular variability in 20 *Picrorhiza kurroa* genotypes was assessed through RAPD analysis. Amplification of DNA of different genotypes using 36 decamer primers (Operon series) revealed 194 bands, out of which 172 (88.65%) were polymorphic. The genotypes could be categorised into four groups named as A, B, C and D. Genetic similarity values among the genotypes ranged from 0.31 to 0.93. The robustness of the groups was confirmed by bootstrap analysis.
• HPLC analysis of rhizome samples of different *P. kurroa* accessions from different geographical locations of Himachal Pradesh showed that Trilokinath (Lahaul Spiti) accession had the maximum content (38.80 g/kg) of Pic I followed by accessions from Barabanghal (Kangra) and Parvati Valley (Kullu). The Picroside II content was maximum (5.96 g/kg) in accessions from Barabanghal (Kangra) followed by those from Parvati Valley (Kullu) and Trilokinath (Lahaul & Spiti).

F. Agricultural Engineering
• The cost of operation of Agria mini tiller was 11-16 per cent and 16-27 per cent higher in dry and wet land conditions as compared to bullock ploughing, respectively.
• Optimum moisture content (15-17%) is required for less grain damage with PAU maize dehusker-cum-sheller operated with power tiller. The capacity of paddy thresher observed was 1600 kg/h which is 6 times higher as compared to traditional system i.e. 1250 kg/h.
• The sequence of capsicum-cabbage-green onion and capsicum-cucumber-french bean gave the maximum production of 1328 and 1042 kg/100m$^2$/year in greenhouse.
• Compared to pure cattle dung based 1 m$^3$ plant, the pure poultry litter feed plant produced 10.4-15.9 per cent total higher gas. The PAU designed slurry handling machine was modified/ refined.
G. Seed Production

- Nucleus seed of soybean (182 kg) and wheat (501 kg) was produced. A total of 29,976 kg breeder seed (11649 kg during Kharif and 18327 kg during Rabi) of different cereals, pulses, oilseeds and vegetables was produced during the period under report.

- Under mega seed project on “Seed production of agricultural crops and fisheries” about 2064 kg seed and 913.5 lakh seedlings/rootlets of forage crops, 1, 20, 800 horticultural plants and 82,000 medicinal and aromatic plants were produced.

H. Tea Husbandry and Technology

- Amongst different sources of sulphur, the application of ZnSO₄, Potash Alum and Gypsum @ 80 kg/ha exhibited comparatively higher yield to the tune of 19.4, 19.2 and 18.5 per cent, respectively. Responses of zinc-sulphur interaction studies showed that interaction of zinc @ 7.5 kg/ha and S @ 60 kg/ha produced the highest yield i.e. 64 per cent increase over control.

- Chemical fertilizers and compost should be applied in the ratio (N: P₂O₅: K₂O 45: 90: 40) + 50% N through Albizia compost or tea skiff compost. The use of tea skiff compost/Albizia compost as an organic source of N nutrition in tea crops along with chemical fertilizers on 50:50 basis can save chemical fertilizers up to 50 per cent.

- Composting and vermicomposting are found to be most successful in tea gardens as there is high availability of recyclable bio-resources throughout the year compared to other crops. Tea skiffing litter makes the best vermicompost with high N content.

I. Agro-forestry and Environment

- The study on lemon grass, wild marigold and Aloe vera conducted in Model Organic Farm revealed that panchang sowing resulted in significant increase in the growth parameters over the non-panchang sowing. Significantly higher plant height, number of off-shoots and plant spread were obtained with addition of homa-bhasm.

- Tea under the plantation of Albizia produced more convincing results and produced 56 per cent more made tea as compared to the control and shading of Toona produced 20 per cent more production of made tea as compared to the control.

- Studies on bio-inoculants in compost enrichment revealed that compost inoculation with bio-inoculants should be used in the farmer’s field before 20 days of inoculation. Agnihotra bhasm supported the growth of bio-inoculants, so bio-inoculants can be integrated with agnihotra bhasm for the management of plant health and diseases.

- Himbio + Neem + Agnihotra, resulted in to minimum incidence of root rot of pea followed by himbio+ agnihotra under in vivo condition. Pea crop sown on Panchang date showed minimum incidence of root rot. Panchang sowing coupled with agnihotra ash gave best control of root rot in pot experiment.

- Lavender transplantation made with the onset of winter rains was found more suitable in terms of survival and oil recovery as compared to monsoon planting. Observations recorded on planting age of lavender (Lavandula officinalis) show that it attains full growth for economical yield after three years of plantation.

J. Horticulture

- Per cent fruit set of pecan was significantly improved by top working as well as by hanging catkins. However, increase in fruit set was 6.4 - 8 per cent by top working and 3.4-6.2 per cent by hanging of catkins in different cultivars than control.

- Increasing pruning intensity resulted in better nut quality but reduced yields significantly, however, treatments where height to spread ratio was kept 1:1.25 and 1:1.15, the nut quality was good and yield was also statistically at par with the maximum yield obtained in control (no pruning). ZnSO₄ @ 0.5 % is best spray treatment for vegetative and nut characters which resulted in maximum yield i.e. 2.46 kg/tree among the four ZnSO₄ sprays.
• Paclobutrazol treatments in pecan decreased the vegetative growth significantly with the increasing concentration. Consequently nut quality was also lowered. Though paclobutrazol @ 2.5 g/tree and 5.0 g/tree reduced the vegetative growth but the nut yield in both treatments was statistically at par with the control.

K. Social Sciences

• District Human Development Report of Kangra revealed that there has been a perceptible improvement in the living conditions of people in the district. The spread of development has also been discernible across all the fourteen development blocks in the district. Various governmental and non-governmental organizations through SHG movement and their related rural development activities have led to the empowerment of the women folk in the district. The performance of the blocks of Bajnath, Nagrota Surian, Bhawarna, Lambagaon, Sulah, Dehra and Nagrota Bagwan with respect to health attainment was relatively better than that of the blocks of Indora, Rait, Fatehpur, Pragpur, Panchrukhi, Kangra and Nurpur.

• The studies on “Improvement of community wastelands through introduction of grass and legumes species in submontane and low hill sub-tropical zone of Himachal Pradesh indicated that the present productivity of the grasslands was 3.52 t/ha and it can be increased by more than four folds by third year with weeding, cleaning and fertilization of the existing grasslands.

• The investigations on diversification of hill agriculture through spice crops cultivation revealed that ginger was most important spice crop of the Himachal Pradesh but now garlic is fast catching up and has taken first position in acreage coverage. Study of market prices in Paonta market showed least price volatility in table purpose ginger prices during the months of November and December, the main production season of the crop. Garlic produce of the state hits the market in the months of May, June and price conditions during these months are generally favorable. June to October is the main production season of tomato crop in the state and its whole sale prices during this period are highly favourable.

• Results of the study on training needs of vegetable growers of Hamirpur district of Himachal Pradesh revealed that a majority of the vegetable growers were old in age with low socio-economic status and belonged to upper caste whereas an overwhelming majority of the respondents were educated. There were 61.7 per cent respondents who were marginal farmers with low total family income and 82.5 per cent farmers who put 0.20–0.33 ha area under vegetable cultivation.

II. HOME SCIENCE

• Results on storage of traditional products revealed that free fatty acids, peroxide value, reducing and non-reducing sugars content of stored products gradually increased with storage intervals though the characteristics such as appearance, taste, flavour, texture, colour, doneness and overall acceptability were found to be acceptable.

• Nutritional evaluation of seabuckthorn and its utilization in the preparation of various food products indicated that during the first phase of the project five different methods were tried to extract juice/pulp from seabuckthorn berries, which could improve the yield/recovery of the pulp.

• Under-utilized crops viz. amaranth, buckwheat, ricebean, horsegram, fingermillet and black cumin had nutritional potential that can be used for supplementation in the preparation of daily consumed recipes. The addition of amaranthus/buckwheat/horsegram up to 15 per cent was acceptable for making good quality chapattis, whereas, the addition of buckwheat up to 20 per cent was acceptable for making cookies and pancake.

• Storage of different chukh prepared with different treatment and sub-treatments showed losses in the nutritional value irrespective of packaging, but green chilli chukh prepared with tamarind showed good effect as compared to red and dried chillies.

• Two new tools were developed for alleviating the drudgery of farm women involved in performing cutting and uprooting operations. The new tools designed and developed namely slashing knife and improved fauda were given to the women and were made to do the task with the new tools. Thus the ergonomic assessment was done involving the physiological and muscular parameters. The results revealed that the physiological parameters such as average and peak heart rate and
average and peak energy expenditure showed a significant reduction but were more than the permissible limits.

- Changes have been incorporated in the *Kilta* with a view to make it more comfortable for carrying out the activity of tea plucking. The fodder collector has also been changed by making it lighter in weight thereby increasing the utility of the tool.

- Studies conducted in the five villages of Bhawarna and Panchrukhi blocks of Kangra district of Himachal Pradesh revealed that there is a need to empower the girls for quality life, girls lack knowledge on vital issues like health, nutrition, ill effects of consanguinity, ideal child bearing age, menarche and hygiene during menstruation.

- The conditions for printing of cotton and silk fabrics with natural dyes namely *Eupatorium* leaves, litchi leaves, *bidens* whole plant, *lantana* leaves were standardized and optimized and tested the dyed and printed fabrics for their colour fastness to washing, crocking and sunlight.

### III. BASIC SCIENCES

- Eighty seven isolates (69 bacterial and 18 fungal) of phosphate (P) solubilizers were isolated from the rhizosphere of *Ocimum basilicum*, *Pelargonium gravelones* and *Tagetes minuta*. Out of these, 48 bacterial and 5 fungal isolates were found to be efficient P-solublizers (forming a zone of more than 5 mm) on Pikovskaya’s medium.

- The periodic incidence of coliforms in some water bodies around Kangra town was monitored. A significant effect of microbiological quality of water was noticed in different seasons.

- 45 species of aromatic and medicinal plants obtained from Herbal gardens established at Jogindernagar (Mandi), Maranda and Gaggal (Kangra), Hamirpur, Solan were introduced in the herbal garden during the year to study their adaptability to this area.

- Himachal bamboo has started flowering and aging and may not survive for a long time. Seminal germplasm was collected and selection of elite seedlings has been made to screen a desirable bamboo for further multiplication in Himachal Pradesh for another 30 years without any fear of flowering.

- Screening of wheat (*Triticum aestivum* L.) genotypes for drought tolerance based on relative water content (RWC %) and other morpho-physiological characteristics revealed that Raj-3765 maintained higher RWC % at 60 DAS, thereby indicating that the variety showed impressive resilience to water stress conditions prevailed during the season.

- The studies conducted on evaluation of pesticide levels and nutritional quality attributes of sesame (*Sesamum indicum* L.) revealed that the overall range of variation in sesame genotypes procured from various AICRP Centres was observed from 2.26-7.32 % in moisture, 14.93-28.04 % in protein, 31.99-53.48 % in oil, 3.92-12.62 % in total sugars, 151-2711 mg/100g in lignin and 259-1808 mg/100g in oxalate content. The genotypes CST-2001 and AVT-07 were adjudged better for their oleic acid (47.56 %) and linoleic acid contents (46.18 %).

- Study on the polyphenolics of tea (*Camellia sinensis* (L) O. Kuntze.) of Himachal Pradesh showed that the total polyphenols and condensed tannins in green tea shoots varied significantly throughout the plucking season. Mean weekly total polyphenols and condensed tannins in the fresh green tea shoots varied in the range of 125.00-207.60g /kg (CD12.69) and 60.08-163.90 g/kg (CD10.09), respectively; whereas in made tea these varied in the range of 61.50-138.70 g/kg (CD6.73) and 20.20-91.80 g/kg (CD4.15), respectively

- Maximum oil content in gobhi sarson was observed in GSL-1 (41.0%) followed by Y-3000 (40.5%) and HNS-0502 (40.1%).

- Trend analysis of the climatic parameters indicated more increase in mean surface air temperature in higher altitudinal area than lower plain area. The increase in the temperature ranged from 0.4°C to 2.4°C in different elevation zones. The rainfall in all elevations and evaporation showed significant decrease up to 2000 m elevation. The water balance studies also indicated a sharp reduction in surplus water in all the elevations.

- The study on developing district-wise surface area of Himachal Pradesh reflected that the actual surface area of entire
Himachal Pradesh, calculated using modern Geo-IT tools, remote sensing and Geographical Information System (GIS) turns out to be 86384.77 km², which is about 36 per cent more than the documented geographical area 55342.79 km².

IV. VETERINARY AND ANIMAL SCIENCES

• The birds of the red jungle fowl were observed to be small to medium in size weighing female as 760.38 ± 107.75 and male as 1169.57 ± 74.92 g. The colour of these birds is a mixture of red, orange, black green colours. The male has bright shades of these colours whereas, females have black buff and reddish brown coloured body. The males found in this region have black feathers on the lower side where as, golden or orange red constitute the upper plumage.

• Results of the study on economical utilization of some available agro-industrial by-products in poultry feed revealed that these by-products (orange peel, orange pulp, kinnow peel and pulp, rose pomace, seabuckthorn pulp, apple pomace and marigold petal meals) can be used in poultry ration as a source of energy and protein by replacing maize and valuable ingredients being used in poultry feed. Biological performance of broilers fed rose pomace and apple pomace as a substitute of energy and protein at 5, 10 and 15 per cent level revealed that it can be substituted at 5-10 per cent level of feeds energy and protein.

• Samples of lung, liver, spleen, trachea, intestine and kidney tissue were received from 2 outbreaks suspected for pasteurellosis among cattle and buffaloes in the State. *Pasteurella multocida* was isolated from one outbreak sample. Serum samples of 15 buffaloes, suspected for chlamydiosis, were received from Animal Diagnostic Laboratory, Vijaywara and one serum sample was found to be positive for Chlamydia antibody.

• *Acinetobacter lwoffii* from eye swabs of canine suffering from conjunctivitis, *Aeromonas hydrophila* from lung, liver and kidney of a leopard cub, *Moraxella phenylpyruvica* from eye of Kaleej pheasant, *Aspergillus* spp. from poultry lung and liver suspected from brooder’s pneumonia, *Candida* spp. and *E. coli*, *Proteus* spp. and *Staphylococcus* spp. were isolated from mastitic milk samples.

• Under AINP on *Haemorrhagic septicaemia*, a total of 504 samples from different animals were collected and processed bacteriologically for isolation of *Pasteurella* species. Out of these samples 18 were found to show positiveness for *Pasteurella* spp. the maximum samples being from Kangra district.

• Under AICRP “Improvement of feed resources and nutrient utilization for raising animal production” a study on mineral status in blood plasma, feed/fodder, water and soil of the animals of Zone I, II and III, revealed calcium, copper and zinc deficiency, which was rectified in case of calcium and reduced to half in copper and zinc by feeding area specific mineral supplements hardly for a period of one month.

• Interactive pharmacokinetic studies on pefloxacin with Trikatu (1:1:1 mixture of *Piper longum*, *P. nigrum* and *Zingiber officinale* at the dose rate of 2 g/goat) in male goats revealed that both loading and maintenance dose of pefloxacin could be decreased by 6 to 15 per cent following pretreatment with Trikatu.

• Of 236 samples screened for prevalence of various gastrointestinal helminths in canines, 125 (53 %) were found positive for one or the other type of infection. *Ancylostoma* sp. (19 %) was the dominant species followed by *Dipylidium caninum* (16 %).

• Some of the important disease conditions recorded during necropsy examination were tuberculosis, catarrhal enteritis, bacterial septicemia, traumatic reticulopericarditis in cattle; asphyxia, pneumonia with chronic obstruction of jejunum in sheep and goats; *Colibacillosis*, hydropericardium syndrome, coccidiosis, CRD, mycotoxicosis, acute pulmonary edema, rickets in poultry and encephalitozoonosis, catarrhal gastroenteritis, hepatopathy leading to cardio respiratory impairment in rabbits.

• Oral and parenteral iron therapy showed a marked improvement in mild to moderate anaemic dogs. Blood transfusion proved a valuable therapeutic tool in critically anaemic dogs.

• Studies on intestinal obstruction in crossbred cattle of high altitude with special reference to prognostic, diagnostic and therapeutic aspects were conducted. The strangulated and simple cranial jejunal obstruction produced severe
pathophysiology within 24 hours and 72 hours of creation, respectively manifested by scant feces with mucosal/diphtheric shreds, hypochloraemia, hypokalemia, haemoconcentration, azotemia with increased plasma alkaline phosphatase and amylase concentration. Similar signs were exhibited in strangulated and simple colonic obstruction from 3rd and 6th post obstruction day, respectively.

- Blood chloride concentration can serve as an important index for selection of fluid to be administered in both types of obstruction and should be maintained around 75mEq/l by giving ringer solution combined with potassium chloride.
- Administration of Gastroprotec syrup in the dose rate of 10ml per animal twice a day orally helps in faster healing of gastric ulceration-erosions in dogs.

- The overall incidence of metestrual bleeding was 12.06 per cent in crossbred cows of Himachal Pradesh. Out of these 79.18 per cent were repeat breeders due to this malady. Incidence of metestrual bleeding was more in heifers as compared to pluriparous cows, however, less heifers were repeat breeders (75.93%) compared to calved animals (80.38%).
- Four types of the glial cells could be classified in the pineal gland of Gaddi goat and Gaddi sheep based on the nuclear morphology. The pineal gland of Gaddi goat and Gaddi sheep, it can be inferred that the gland is more active in summer and least active in autumn coinciding with the sexual activity of these small ruminants. As the pineal gland has antigonadotropic effect, the increased activity of the gland (in summer) has the converse (decreased) effect on the sexual activity on Gaddi goat and Gaddi sheep while the decreased activity (in autumn) of the gland has an opposite (increased) effect on the sexual activity of these animals.
- Genetic improvement of mirror carp and scale carp by selective breeding enhanced the growth rate, feed conversion efficiency, survivability and disease resistant strain of common carp but the prolonged winter decreased the fecundity rate of fish.
- In Mahseer feed the fishmeal can be replaced up to 57 per cent by roasted soybean and feed conversion ratio is found almost similar in both the diets. Further, it is observed that sudden decrease in temperature (from 21°C to 16°C) creates a stress environment, which is vulnerable for the fungal infection.
- The growth of fish fauna was recorded higher in the ponds manured with rabbit excreta followed by old and fresh cow dung. The enhanced growth in case of rabbit excreta may be attributed to the availability of total nitrate-nitrogen.
- The composition and acceptability of paneer made from different milk were studied. The standardized milk (fat 4.5 %, 3.0 %, 1.5 % and 0.5% and SNF 8.5 %, 8.5 %, 9.0% and 8.7%, respectively) was used for the study. The data revealed that the yield of paneer was highest when prepared from milk having high fat percentage.
- Indigenous Technical Practices used by HP livestock farmers against 19 most prevailing disease conditions and husbandry practices have been identified.
DETAILED RESEARCH ACHIEVEMENTS

I. AGRICULTURE

A. Crop Improvement

During the period under report, Varundhan variety of paddy, HPW-211, HS-420 and VL gehun 829 of wheat and SML-668 of summer moong have been released for general cultivation in the state.

Rice

- Varundhan, a new variety of rice has been released by the State Variety Release Committee for cultivation under transplanted irrigated conditions in hilly areas of HP (1000 m asl) particularly in Kullu, Mandi and Shimla districts. It is a red grain variety with average yield of 3210 kg/ha, giving an increase of 96.9 per cent over local variety Jattoo (1630 kg/ha) and 77.3 per cent increase over Naggar Dhan (1810 kg/ha). It is resistant to leaf and neck blast, brown spot and sheath rot. It is early maturing (142-145 days), semi-dwarf, lodging resistant and cold tolerant variety with good cooking quality.
- Hybrid Rice (HRI-152) from Bayer Crop Science with an average yield of 7080 kg/ha having field resistance to rice blast in mid hills and with superiority in grain yield of 61 per cent over HPR-2143 and of 27 per cent over HPR-2344 has been recommended for cultivation under mid hills below 1000 m for assured irrigated areas of HP (Table 1).
- Under irrigated conditions, HPR-2337, HPR-2373, HPR-2529 and HPR-2530 have been found promising cultures which yielded more than 4500 kg/ha over years.
- Pusa Sugandh 2, a scented long grain culture from IARI performed very well in mid-hills and yielded around 4600 kg/ha at Malan and 6200 kg/ha at Dhaulakuan. This variety is early maturing, highly scented but moderately susceptible to blast.
- Under rainfed conditions, HPR-2403, HPR-2410, HPR-2529 and HPR-2530, strains of cross HPU-741/IR 18482-3-2-3-4-1-1-1 performed well over the last two years and yielded more than 3200 kg/ha.
- Recessive genes xa 5, xa 8 and xa 13 and dominant gene Xa 21 imparted resistance to the BB isolate from Rajiana in the mid-hills of Himachal Pradesh. Resistant genes are being transferred to the susceptible variety Sabarmati in collaboration with the Biotechnology Centre of the university.
- In upland paddy, out of 11 lines evaluated, the lines VL-30240 (3300 kg/ha), HPR-2530 (3250 kg/ha) and HPR-2363/ HPR-2504 (3000 kg/ha)

Table 1. Performance of HRI-152 over the years

<table>
<thead>
<tr>
<th></th>
<th>Malan</th>
<th></th>
<th></th>
<th>Dhaulakuan</th>
<th></th>
<th></th>
<th>DF</th>
<th>Blast (0-9)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2005</td>
<td>2006</td>
<td>Mean</td>
<td>2005</td>
<td>2006</td>
<td>Mean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HRI-152</td>
<td>8810</td>
<td>6810</td>
<td>7810</td>
<td>5660</td>
<td>8500</td>
<td>7080</td>
<td>112</td>
<td>0</td>
</tr>
<tr>
<td>HPR-2321</td>
<td>6730</td>
<td>5390</td>
<td>6060</td>
<td>5620</td>
<td>5500</td>
<td>5560</td>
<td>110</td>
<td>0</td>
</tr>
<tr>
<td>HPR-2344</td>
<td>5900</td>
<td>6250</td>
<td>6070</td>
<td>4760</td>
<td>6420</td>
<td>5590</td>
<td>109</td>
<td>1</td>
</tr>
<tr>
<td>IR-64</td>
<td>6160</td>
<td>6150</td>
<td>6150</td>
<td>3940</td>
<td>6040</td>
<td>4990</td>
<td>110</td>
<td>1</td>
</tr>
<tr>
<td>HPR-2143 (L’Ck)</td>
<td>4770</td>
<td>4900</td>
<td>4840</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>99</td>
<td>1</td>
</tr>
</tbody>
</table>
performed better in respect of yield and disease resistance at Sundernagar. At Katrain, Yunlen-4 (3400 kg/ha) significantly out yielded the highest yielding check variety, Kunjen-4 (1980 kg/ha).

**Maize**

- On the basis of multilocational evaluation of maize hybrids of private companies during Kharif 2006, Bisco-855 (7026 kg/ha), S-621 (7001 kg/ha), HM-105 (6803 kg/ha), Bisco-844 (6795 kg/ha) and X-640 (6792 kg/ha) were top five best hybrids (Table 2) and were recommended for cultivation within the State.

- DKI-9205 was identified as a stable source of resistance against ESR as it showed immune reaction during the last three years of testing. It is an early maturing inbred evolved from AB (yellow) broad based pool having pedigree Sr. 231-2-1-1-1-1. Five other early maturing inbreds DKI-9404, DKI-9721, DKI-9725, DKI-9772 and LYPsara were identified to be a stable source of resistance.

- Among medium maturing inbreds, DKI-9770 was categorized highly resistant (<10% incidence) and thus identified to be stable source of resistance on the basis of three years of screening. It was evolved from CVT material and has pedigree HS.14-2-1-1-2-1-2-2.Two other lines DKI-9712 and 94144-FARAKKA-BA have confirmed resistance.

- Out of twenty two CM lines evaluated for two years, CM108 and CM125 have been found to be highly resistant (<10 % incidence).

- Hybrids DKH-0517, DKH-0516 and DKH-0624

**Table 2. Performance of maize hybrids for seed yield (kg/ha) in Himachal Pradesh, Kharif 2006**

<table>
<thead>
<tr>
<th>Entry / Variety</th>
<th>Company/ Organization</th>
<th>Akrot</th>
<th>Bajaura</th>
<th>Berthin</th>
<th>D/kuan</th>
<th>Kangra</th>
<th>P/pur</th>
<th>S/Nagar</th>
<th>Overall mean</th>
<th>% increase over Girija</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bisco-844</td>
<td>Bisco Biosciences</td>
<td>5703</td>
<td>8205</td>
<td>3491</td>
<td>3501</td>
<td>6074</td>
<td>7445</td>
<td>6550</td>
<td>5853 (6)</td>
<td>21.35</td>
</tr>
<tr>
<td>Bisco-855</td>
<td>do-</td>
<td>5775</td>
<td>9179</td>
<td>4897</td>
<td>4217</td>
<td>6074</td>
<td>7881</td>
<td>6220</td>
<td>6321 (1)</td>
<td>31.05</td>
</tr>
<tr>
<td>X-640</td>
<td>Aruna Seeds</td>
<td>4115</td>
<td>9575</td>
<td>3942</td>
<td>3376</td>
<td>5931</td>
<td>7301</td>
<td>7040</td>
<td>5898 (5)</td>
<td>22.27</td>
</tr>
<tr>
<td>HM-105</td>
<td>Bhartiya Beej Nigma</td>
<td>4191</td>
<td>8707</td>
<td>3369</td>
<td>4401</td>
<td>6773</td>
<td>6972</td>
<td>7370</td>
<td>5969 (4)</td>
<td>23.76</td>
</tr>
<tr>
<td>Kaveri-2020</td>
<td>Kaveri Seeds</td>
<td>2876</td>
<td>8883</td>
<td>3890</td>
<td>3703</td>
<td>6060</td>
<td>7209</td>
<td>7490</td>
<td>5741 (8)</td>
<td>18.81</td>
</tr>
<tr>
<td>Kaveri-218</td>
<td>do-</td>
<td>4191</td>
<td>9431</td>
<td>2379</td>
<td>4776</td>
<td>6449</td>
<td>6388</td>
<td>7100</td>
<td>5816 (7)</td>
<td>20.59</td>
</tr>
<tr>
<td>Kaveri-224</td>
<td>do-</td>
<td>3195</td>
<td>8670</td>
<td>1407</td>
<td>2921</td>
<td>5972</td>
<td>6671</td>
<td>8890</td>
<td>5390 (10)</td>
<td>11.74</td>
</tr>
<tr>
<td>Kaveri-225</td>
<td>do-</td>
<td>3594</td>
<td>9003</td>
<td>3508</td>
<td>2591</td>
<td>6907</td>
<td>6665</td>
<td>7520</td>
<td>5685 (9)</td>
<td>17.85</td>
</tr>
<tr>
<td>X-404</td>
<td>Kanchan Ganga</td>
<td>4732</td>
<td>7833</td>
<td>3525</td>
<td>2827</td>
<td>4768</td>
<td>7041</td>
<td>6620</td>
<td>5323 (11)</td>
<td>10.62</td>
</tr>
<tr>
<td>X-453</td>
<td>do-</td>
<td>4801</td>
<td>9376</td>
<td>5957</td>
<td>4696</td>
<td>5527</td>
<td>6882</td>
<td>6930</td>
<td>6310 (12)</td>
<td>30.83</td>
</tr>
<tr>
<td>S-621</td>
<td>Spriha Bioscience</td>
<td>3106</td>
<td>8791</td>
<td>3855</td>
<td>3848</td>
<td>6750</td>
<td>7008</td>
<td>9350</td>
<td>6102 (13)</td>
<td>26.50</td>
</tr>
<tr>
<td>Swati</td>
<td>FIL Industries</td>
<td>4651</td>
<td>7956</td>
<td>1615</td>
<td>3182</td>
<td>7314</td>
<td>5846</td>
<td>5880</td>
<td>5206 (12)</td>
<td>7.95</td>
</tr>
<tr>
<td>Girija** (C)</td>
<td>CSKHPKV</td>
<td>3952</td>
<td>7736</td>
<td>1806</td>
<td>2369</td>
<td>5944</td>
<td>5066</td>
<td>6897</td>
<td>4824 (13)</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Composite, Figures in parentheses indicate the rank of the hybrid**
were found to combine high grain yield and resistance against ESR. These will be evaluated further through multi-location testing and under artificial inoculation.

- Two entries of medium maturity viz; KLM-7 and KLM-14 gave 10 per cent and 16.1 per cent higher yield over the best check Navjot when averaged over locations and thus have been promoted to AVT under AICMIP. Two entries of early maturity viz; KLM-1 and KLM-15 from Kangra centre gave 26.2 per cent and 38.9 per cent, higher yield over best check Surya and have been promoted to IET during Kharif 2007.

- Based upon their performance, two entries of early maturity KLM-9 and KLM-11 and two of medium maturity viz; KLM-12 and KLM-18 have been inducted into zonal trials for Zone-1 during Kharif 2007.

- In specialty corn types, HQPM-1 and FQH-4567 of Quality Protein Maize, Win Orange-a sweet corn variety and Amber-a Pop corn variety were identified for Zone-1(HP).

- A medium maturing composite L-173 which showed 9.8 per cent superiority over check Navjot in first year trial at Bajaura was promoted for final stage of testing in coordinated trials.

- Two medium maturity composites viz; L-229, L-230 gave 13.2 and 19.2 per cent higher yield over check Navjot, respectively.

- Two early maturing experimental hybrids viz., EHB-1584 and EHB-1585, which gave 17 and 20 per cent higher yield than the check HIM-129. As a result both these hybrids have been promoted for next stage of testing in coordinated trials (IET).

- A medium maturing experimental hybrids EHB-1589 (9835 kg/ha) gave significantly higher yield than the best check Bio-9637 (8245 kg/ha) in zonal trial. This hybrid was promoted for testing in coordinated trials.

Wheat

- Three wheat varieties HPW-211, Shivalik (HS-420) and VL Gehun-829 have been released by SVRC for cultivation in H.P. under low hills (timely sown irrigated) and mid-hill conditions (late sown) and low and mid-hill conditions (early sown), respectively.

- HPW-211 is a high yielding variety (3470 kg/ha) having tolerance to Karnal bunt and genetic diversity for resistance to brown rust, yellow rust and powdery mildew. It matures in 168 days. The grains are amber and hard with average 1000 grain weight of 31.4 grams. This variety is suitable for cultivation in Zone I under timely sown irrigated conditions.

- HS-420 is a high yielding wheat variety (2700 kg/ha) having high degree of resistance against stripe and leaf rust. It is suitable for cultivation in the low and mid hill areas of the state. It is responsive to fertilizer application with protein content of 11.4 per cent.

- VL Gehun-829 is a high yielding variety (2500-3000 kg/ha) having high degree of resistance to stripe rust, leaf rust and loose smut. This variety is suitable for cultivation under early sown rainfed conditions in low and mid hills.

- HPW-251 (2309 kg/ha) have been found to be promising under early sown conditions and is in the final year of testing exhibiting significantly higher yield than all the check varieties in early sown advance varietal trial.

- Seven doubled haploids of wheat viz., DH-114 and DH-452 (early sown), DH-776, DH-5, DH-199 and DH-100 (timely sown) and DH-40 (late sown) developed through chromosome elimination mediated technique following wheat x maize and wheat x Imperata cylindrica system have been projected as potential genotypes to be evaluated for diseases through IDSN by the AICWIP, Karnal and for grain yield potential through station trials of the University.

- Variety HPW-236 was evaluated under on-farm trials in high altitude areas. It gave an average yield of 3302 kg/ha in comparison to 2630 kg/ha of check variety HPW-155.

- HPW-267 (2778 kg/ha), TL-2949 (2343 kg/ha),
VL-907 (3460 kg/ha) and HS-495 (3329 kg/ha) have been found to be promising under timely sown rainfed conditions, while VL-898 (2235 kg/ha), TL-2949 (2235 kg/ha), HPW-267 (2099 kg/ha) and VL-895 (1967 kg/ha) have been found to be promising under timely sown irrigated conditions in coordinated trials.

- HS-490 (1963 kg/ha), HS-502 (1372 kg/ha), VL-913 (13.04 kg/ha), HS-493 (1304 kg/ha) and UP-2696 (1331 kg/ha) have been found to be promising under late sown conditions at Malan. PW-898 and PW-901 were found to be promising based on grain yield and disease resistance.
- Different wheat strains developed at three research stations Malan, Dhaulakuan and Bajaura have been found to be resistant to yellow and brown rust under the IPPSN (Initial Plant Pathological Screening Nursery) 2006-07. Of these, DW-75, DW-76, DW-84, DW-88, DH-100, PW-895, PW-896, PW-898, PW-903 and PW-901 were found resistant to brown rust; PW-894, PW-901 resistance to yellow rust and only DH-100 was resistant to both rusts.

**Barley**

- At Bajaura, HBL-501 (2989 kg/ha) and dual purpose HBL-410 (1134 kg/ha) qualified for evaluation in All India coordinated trials for northern hill zone. Both the entries were free from yellow rust disease.
- Two entries, BHS-365 and BHS-410 were observed to be superior as dual purpose (grain & fodder) varieties.
- At Berthin, genotype BHS-368 significantly gave higher dry biomass (8324 kg/ha) and grain (3570 kg/ha) yield.

**Pulses**

- Himachal Mash-1 (UPU 00-31), a new variety of mash, has been recently recommended for cultivation in submontane low hills sub-tropical zone of HP. It is compact and erect in growth habit, bearing 37-40 pods per plant having 6-7 seeds per pod. Seeds are brownish black in colour. It is synchronous in maturity and matures in about 74-76 days. The variety has an average yield of 1400-1600 kg/ha with resistance to anthracnose, leaf spot, viral disease and tolerance to Cercospora.
- Genotypes KU-154 and KU 4-223, have been found promising genotypes for intercropping as well as sole cropping in maize. These genotypes are being tested at farmers’ field and are resistant to anthracnose and MYMV.
- At Bajaura, mash (urd) KU 5-527 (1340 kg/ha) performed better over the check variety, Palampur-93 (1160 kg/ha). DKM-14 (1930 kg/ha) and DKM-13 (1900 kg/ha) were found promising over PDU-1 (1430 kg/ha).
- Summer moong, SML-668 has been released for
cultivation in zone-I. This variety is having an average yield of 1270 kg/ha as compared to the variety Pusa Baisakhi (940 kg/ha) and SML-134 (950 kg/ha). It matures in about 75-85 days. It is synchronous in maturity with dull green bold grains and with white hilum. It is resistant to Cercospora leaf spot and yellow bean mosaic virus. It is suitable for summer season as a contingent crop i.e. after ginger, potato and sugarcane harvesting or intercropping in sugarcane.

- Chickpea genotype GPF-2 has been found to be high yielding and resistant to Ascochyta blight. On farmers field this genotype has performed very well. C-71, C-61, C-121, C-123 and G-127 gave significantly higher grain yield as compared to the check ICCV-90201.

- In Desi gram, lines 88-2 (1840 kg/ha), ICCV-95503 (1780 kg/ha), line- 333 (1640 kg/ha), were found promising. In Kabuli type chickpea, genotypes CSU-8927 (1119 kg/ha) ICCV-95428 (1016 kg/ha) were found superior than check ICCV-6 (870 kg/ha).

- The highest dry grain yield was recorded in chickpea, ICCV-06301 (677 kg/ha) followed by ICCV-06304 (520 kg/ha) compared to desi check variety HPG-17 (729 kg/ha).

- At Kukumseri, among 25 wild cicer accessions, 17 accessions showed regeneration during summer season of 2007. Of these 9 accessions flowered and set seed.

- A white seeded dual purpose variety of cowpea, Himachal Lobia-2 (C-519) has been recommended for cultivation in submontane low hills subtropical zone of HP. It has average green pod yield of 4500-5000 kg/ha with tender green pods with less beany flavour and having resistance to cercospora leaf spot and mosaic.

- Two on-farm trials of cowpea with cultivars, C-519 (dual purpose i.e. as green pods for vegetable and as dal after ripening) were tested at Jhiri and Bajaura villages. On an average C-519 gave grain yield of 1570 kg/ha as compared to the check variety C-475 (1250 kg/ha). C-519 in addition, gave green vegetable yield of 3610 kg/ha. At Berthin, C-519 gave highest dry grain yield of 993 kg/ha and 1214 kg/ha under fertilizer and non-fertilizer applications, respectively.

- In rajmash, 15 promising lines were evaluated for yield and its related traits at Sangla. SR 6-9 and SR 5-3 were found higher yielder. At Katrain, bush type rajmash HPR-220(A) (740 kg/ha) gave significantly higher yield than the check variety, HIM-1 (570 kg/ha).

- In intercropping experiment with maize, the rajmash genotypes 62-1-P-1(1320 kg/ha), IC-16832 (1150 kg/ha), HPR-207 (880 kg/ha) and Kothi Selection (720 kg/ha) were found to yield significantly higher than the check variety Kanchan (310 kg/ha).

- At Kukumseri, among 375 genotypes of rajmash evaluated, eleven indeterminate type and six determinate type germplasm lines (early maturing and high yielding) were selected.

- Lentil genotype, DPL-61 has been found to be high yielding and resistant to rust. This genotype has been tested at farmers’ field. Besides this genotypes viz.; L 6-324, L6-318 and L 6-316 also gave significantly more yield than the best check HPL-5.

- Under contingent crop planning experiment at Berthin, sesame cv. LTK-4 recorded the highest biomass yield (2088 kg/ha) followed by cowpea cv. C-475 (1804 kg/ha). The dry grain yield was highest in C-475 (1110 kg/ha) of cowpea followed by C-519 (902 kg/ha).

- Amongst the field garden pea FP-198 field type gave higher grain yield (1815 kg/ha) followed by FP-196 (1220 kg/ha) and Rachna (1130 kg/ha).

- In kulthi, strains HG-1, HG-3 and HG-15 were found to be high yielding as compared to check HPK-4.

- Two ricebean genotypes BRS-1 and BRS-2 gave significantly higher seed yield. These can be released as new variety for the state as no variety has been released yet. These are presently being
tested at farmers’ field.

Oilseeds

- BCRS-17 of karan rai recorded the highest seed yield (1213 kg/ha) followed by HC-9605 (958 kg/ha) in comparison to the best national checks Kiran (859 kg/ha) and local check Jayanti (745 kg/ha). The entry BCRS-17 also showed moderate resistant reaction against Alternaria brassicae both at leaf and pod stages. The entry BCRS-17 remained the top yielder during the last five years and gave an average seed yield of 1419 kg/ha (Table 3).
- In Karan rai, AVT-I (rain fed) trial, Pusa Swarnim appeared as top seed yielder (1350 kg/ha) followed by local check Jayanti (1135 kg/ha). Kiran exhibited the highest per cent oil content (42.5 %) followed by Pusa Swarnim (40.9 %) and Jayanti (40.4 %). In IVT (rain fed) trial, the strain BCS-1 recorded the highest seed yield (1544 kg/ha) followed by the local check Jayanti (1006 kg/ha) and best check Kiran (933 kg/ha) at Kangra.
- In brown sarson, the strain HPBS-1 appeared as significantly top seed yielder (1296 kg/ha) followed by KDH-BS-6 and 02-KLM-6 in comparison to the best local check KBS-3 (1059 kg/ha).
- At Bajaura, in gobhi sarson, ONK-1 gave significantly higher yield (3670 kg/ha) than the check variety, Neelam (2220 kg/ha). In AVT-I + AVT-II trial, the strain ONK-1 of gobhi sarson from Kangra centre appeared as significantly highest seed yielder (1709 kg/ha) in comparison to the best zonal check RL-1359 (1331 kg/ha). The strain ONK-1 (bold seeded) also recorded the significantly highest seed yield at Dhaulakuan (1259 kg/ha) as against the best check Kranti (875 kg/ha) and at Palampur (2733 kg/ha) as against the best zonal check RL-1359 (2460 kg/ha). This strain also showed its superiority in station trial by giving higher yield (1604 kg/ha) in comparison to the best local check Neelam (1351 kg/ha).
- In soybean, out of 13 genotypes tested, the lines A VT-1 8 T H 388 x NRC-2 (1999 kg/ha), P1-1-1-1 PK 1053 x P7-1-1 (1944 kg/ha) and P 69-3-1-1-1 PK 1053 x Himso-107 (1930 kg/ha) performed better in respect of disease as well as yield at Sundernagar. P 1-2 (SL-284 x Bragg) and P 12-3-3(SL-284 x Bragg) of soybean were found to be high yielding (1597 kg and 1513 kg/ha, respectively) as compared to check Bragg (1430 kg/ha).

<table>
<thead>
<tr>
<th>Strains</th>
<th>2002-03</th>
<th>2003-04</th>
<th>2004-05</th>
<th>2005-06</th>
<th>2006-07</th>
<th>Average seed yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCRS-17</td>
<td>1941 (40.7)</td>
<td>1241</td>
<td>969 (43.4)</td>
<td>1733 (39.5)</td>
<td>1213 (41.3)</td>
<td>1419 (41.2)</td>
</tr>
<tr>
<td>Kiran</td>
<td>1556 (42.8)</td>
<td>787</td>
<td>844 (44.6)</td>
<td>1640 (39.7)</td>
<td>859 (40.8)</td>
<td>1137 (42.0)</td>
</tr>
<tr>
<td>PC-5-17</td>
<td>1065</td>
<td>635 (43.2)</td>
<td>1404 (40.2)</td>
<td>716 (39.4)</td>
<td>955 (40.9)</td>
<td></td>
</tr>
<tr>
<td>JTC-1</td>
<td>1496 (39.3)</td>
<td>1185</td>
<td>833 (43.9)</td>
<td>1654 (39.6)</td>
<td>745 (41.2)</td>
<td>1183 (41.0)</td>
</tr>
<tr>
<td>HC-9603</td>
<td>1275 (37.3)</td>
<td>-</td>
<td>729 (42.6)</td>
<td>1631 (41.5)</td>
<td>861 (39.2)</td>
<td>1124 (40.2)</td>
</tr>
<tr>
<td>HC-9605</td>
<td>1619 (38.5)</td>
<td>1134</td>
<td>899 (44.4)</td>
<td>1404 (41.2)</td>
<td>958 (40.8)</td>
<td>1203 (41.1)</td>
</tr>
<tr>
<td>PCC-5</td>
<td>1415 (39.7)</td>
<td>1093</td>
<td>715 (43.7)</td>
<td>1423 (39.7)</td>
<td>718 (39.0)</td>
<td>1073 (40.5)</td>
</tr>
<tr>
<td>JTC-11</td>
<td>1785 (42.0)</td>
<td>611</td>
<td>854 (43.4)</td>
<td>-</td>
<td>-</td>
<td>1083 (42.7)</td>
</tr>
<tr>
<td>DLSC-03</td>
<td>1889 (41.2)</td>
<td>926</td>
<td>628 (44.5)</td>
<td>1385 (41.1)</td>
<td>-</td>
<td>1207 (42.7)</td>
</tr>
<tr>
<td>Grand mean</td>
<td>1622</td>
<td>1005</td>
<td>790</td>
<td>1534</td>
<td>867</td>
<td></td>
</tr>
<tr>
<td>CD (%)</td>
<td>283*</td>
<td>154**</td>
<td>120@</td>
<td>94#</td>
<td>162$</td>
<td></td>
</tr>
<tr>
<td>CV (%)</td>
<td>10.9</td>
<td>9.6</td>
<td>10.2</td>
<td>4.0</td>
<td>12.2</td>
<td></td>
</tr>
</tbody>
</table>

* Based on 10 entries ** Based on 13 entries @ Based on 18 entries
# Based on 17 entries $ Based on 14 entries

Figures in parentheses indicate per cent oil content.
• Under mid hill conditions of H.P., Himani (KL-214) variety of linseed remained at par with Nagarkot and produced significantly higher seed yield of linseed compared to Baner (KL-224) and Binwa (KL-210)

Fodder Crops

• Among fodder crops, a napier-bajra hybrid entry PNB-93, S-17 of Setaria, HGP-2, GG-05-05 of guinea grass, SSG-3 (sorghum–sudan grass hybrid), BL-180 of berseem and two varieties of oats viz., JHO-99-1 (single cut), RO-19 (multi cut) and PWC-3 of white clover were observed to be superior.

Underutilized Crops

• Buckwheat variety (Sangla B-1) has been released by the Central Variety Release Committee for zone-IV of Himachal Pradesh.

• Among 90 genotypes of buckwheat evaluated, Sangla-1, EC 216629, EC 272734-1 and IC16-2 performed better with respect to yield and yield contributing traits.

• Under AICRP on underutilized crops, 11 entries in IVT, three in AVT-I and one in AVT-II were evaluated with 5 checks, IC-310095 (3704 kg/ha) in IVT, IC-274439 (2898 kg/ha) in AVT-I and SMLBW-3 (3731 kg/ha) in AVT-II and these performed better over the best check Himpriya (4009 kg/ha). 20 genotypes of grain amaranth were evaluated for grain yield and other traits. Genotype RMA-19 and (3367 kg/ha) and IC 095341 (2961 kg/ha) were found higher yielder than the best check out of four IC 035407 (2144 kg/ha).

Vegetables

• In garden pea, Punjab-89 variety was observed to be promising with respect to yield, green pods, number of seeds/pod and powdery mildew resistance. In addition, line VP-233 gave significantly highest pod yield. Pea lines KS-6, PC-531, DPP-3, VL-6, IC-208388 and IC-208391 were also promising with respect to yield and resistance to powdery mildew and root-rot wilt complex.

• Among the cauliflower varieties, Hybrid Radha gave a yield of 25.9 t/ha when compared with Palam Uphar (14.80 t/ha) at Dhaulakuan. At Akrot, cauliflower cultivar, DC-5 gave highest marketable yield (28.07 t/ha) followed by DC-76 (26.62 t/ha). Lowest yield (21.97 t/ha) was recorded in cultivar PN-I. Cauliflower genotypes namely, Fysiyama, Agrotech and Sweta were found promising for net curd yield and they also produced high quality snow white curds.

• In cabbage, the round type genotypes Sanjivni was found promising with respect to head yield and compactness of heads. The genetic phenomena of sporophytic self-incompatibility (SSI) and cytoplasmic male sterility (CMS) are being investigated for their use in the development of hybrids.

• Hybrid Fiesta of broccoli recorded a yield of 16.70 t/ha followed by Palam Kanchan with 14.40 t/ha.

• In tomato, bacterial wilt resistant genotype Hawaii-7998 performed better than the checks. Bacterial wilt resistant tomato genotypes namely, Megha Tomato-2, BL-333-3, Hawaii-7998 and H-62 were found promising for fruit yield (Table 4). Studies on evaluation of tomato germplasm against ‘Leaf Curl Virus’ revealed that JKTH-
3098, ARTH-734, ARTH-1001 and TLBRH-2 were highly resistant where as TLBRH-6, H-24, Anup-1113 and TBK-01113 were resistant and Punjab Chhuhara was susceptible to ‘Tomato Leaf Curl Virus’ at Dhaulakuan. Marketable fruit yield was highest in ARTH-1001 (21.77 t/ha) followed by ARTH-734 (20.13 t/ha).

Table 4. Performance of tomato genotypes against bacterial wilt at Bajaura

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Total fruit yield (t/ha)</th>
<th>% increase over check (BT-1)</th>
<th>Mean fruit weight (g)</th>
<th>Pericarp thickness (mm)</th>
<th>Disease reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>LE-626</td>
<td>18.23</td>
<td>-</td>
<td>37.46</td>
<td>4.32</td>
<td>MR</td>
</tr>
<tr>
<td>Megha Tomato-2</td>
<td>29.81</td>
<td>47.0</td>
<td>40.20</td>
<td>4.63</td>
<td>R</td>
</tr>
<tr>
<td>LE-1-2</td>
<td>17.24</td>
<td>-</td>
<td>32.36</td>
<td>3.97</td>
<td>R</td>
</tr>
<tr>
<td>BL-333-3</td>
<td>30.76</td>
<td>51.7</td>
<td>42.90</td>
<td>4.96</td>
<td>R</td>
</tr>
<tr>
<td>Hawaii-7998</td>
<td>25.81</td>
<td>27.3</td>
<td>21.80</td>
<td>3.43</td>
<td>R</td>
</tr>
<tr>
<td>BT-1 (check)</td>
<td>20.27</td>
<td>-</td>
<td>31.80</td>
<td>4.08</td>
<td>R</td>
</tr>
<tr>
<td>Pusa Ruby (SC)</td>
<td>NR</td>
<td>-</td>
<td>NR</td>
<td>NR</td>
<td>HS</td>
</tr>
<tr>
<td>Roma (SC)</td>
<td>NR</td>
<td>-</td>
<td>NR</td>
<td>NR</td>
<td>HS</td>
</tr>
<tr>
<td>Solan Gola (SC)</td>
<td>NR</td>
<td>-</td>
<td>NR</td>
<td>NR</td>
<td>HS</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>1.90</td>
<td>-</td>
<td>3.34</td>
<td>0.15</td>
<td>-</td>
</tr>
<tr>
<td>CV (%)</td>
<td>0.45</td>
<td>-</td>
<td>5.36</td>
<td>1.99</td>
<td></td>
</tr>
</tbody>
</table>

R: Resistant Reaction; MR: Moderately Resistant; HS: Highly Susceptible; NR: Not recordable

- In okra, line IC-90269 gave the highest fruit yield followed by IC-32398 and IC-31850. Line 169469 was found promising for shorter inter-nodal length. At Dhaulakuan, variety AROH-465 has given higher yield as compared to Pb.-8.
- In onion, the highest yield (52.6 t/ha) was obtained in DPO-1, whereas recommended variety Patna Red gave yield of 35.5 t/ha.
- In case of carrot, genotype KTCTH-7 was found promising for yield and earliness. It recorded significantly maximum marketable root yield (19.05 t/ha) compared to all other genotypes (Table 5). In case of root length, the promising genotypes were KTCTH-7 and KTCTH-8.
- Two clones of colocasia DKCH and DKCK-1 have been identified to be significantly superior to other entries with respect to yield. Mean yield of these over years was 17.0 t/ha and 15.1 t/ha, respectively.
- Low tunnel polyhouse technology appeared promising for healthy and off season nursery production of vegetables at Kukumseri.
Table 5. Performance of carrot genotypes at Bajaura

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Days to maturity</th>
<th>Marketable root yield (t/ha)</th>
<th>Root length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KTCTH-7</td>
<td>68.7</td>
<td>19.05</td>
<td>15.56</td>
</tr>
<tr>
<td>KTCTH-8</td>
<td>83.0</td>
<td>13.01</td>
<td>15.16</td>
</tr>
<tr>
<td>Pusa Yamdagini (C)</td>
<td>72.3</td>
<td>13.83</td>
<td>14.83</td>
</tr>
<tr>
<td>E. Nantes</td>
<td>82.6</td>
<td>12.31</td>
<td>14.30</td>
</tr>
<tr>
<td>Chanteny</td>
<td>110.3</td>
<td>12.61</td>
<td>13.60</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>3.66</td>
<td>4.04</td>
<td>1.22</td>
</tr>
<tr>
<td>CV (%)</td>
<td>2.33</td>
<td>1.44</td>
<td>4.43</td>
</tr>
</tbody>
</table>

- In chilli, 2 genotypes JKC-101 and Anugrah exhibited resistance against bacterial wilt.
- Over the years DKGD variety of ginger has recorded the highest yield of 13.3 t/ha which is significantly superior in all other entries.
- In common methi, DPF-205 gave highest green yield (8.0 t/ha) and seed yield (16.0 t/ha) whereas Pusa Kasuri gave highest fresh yield of 9.5 t/ha and seed yield of 6.0 t/ha. All other genotypes except DPF-205 were highly susceptible to powdery mildew. Cultivar Methi No. 205 gave the highest seed yield (8.6 t/ha) followed by Methi RK (8.0 t/ha) and Methi PEB (7.7 t/ha) which were at par with each other.
- In turmeric, the promising lines viz. DPT-1 and DPT-2 have been identified for cultivation in the state. Two clones DKNT-8 (24.6 t/ha) and DKNT-9 (23.4 t/ha) have been identified to be yielding significantly higher over the other entries. Both entries have been found to moderately resistant to TLS disease at Dhaulakuan.

**Sugarcane**

Table 6. Production potential and economics of different cropping sequences (2006-07)

<table>
<thead>
<tr>
<th>Crop sequences</th>
<th>Yield main product (kg/ha)</th>
<th>Maize grain equivalent (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kharif</td>
<td>Intercrop</td>
</tr>
<tr>
<td>Maize–wheat</td>
<td>1944</td>
<td>4054</td>
</tr>
<tr>
<td>Babycorn + Frenchbean (pole type)-pea-summer squash</td>
<td>5003</td>
<td>363</td>
</tr>
<tr>
<td>Babycorn + Asparagus beans– pea - summer squash</td>
<td>6134</td>
<td>772</td>
</tr>
<tr>
<td>Brinjal - wheat</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Brinjal - garlic</td>
<td>139</td>
<td></td>
</tr>
<tr>
<td>Brinjal - brocolli - potato</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Okra - wheat</td>
<td>5480</td>
<td></td>
</tr>
<tr>
<td>Okra – cauliflower - Frenchbean (bush type)</td>
<td>5396</td>
<td></td>
</tr>
<tr>
<td>Okra – radish - onion</td>
<td>6035</td>
<td></td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Cultivars Co-97015 and Co-98014 have been identified as high yielding and having field resistance against red rot and are under evaluation at farmers’ field.

**B. Crop Management**

**Cropping systems**

- Under mid hill conditions of Himachal Pradesh, babycorn + french bean (pole)-pea-summer squash, babycorn + asparagus bean-pea-summer squash, okra-cauliflower-french bean (bush type) and okra-radish-onion were more productive and remunerative cropping sequences than maize-wheat sequence (Table 6).
- Maize-toria-wheat followed by maize-gobhi sarson gave significantly higher maize equivalent yield over traditional maize-wheat cropping sequence under low hills rainfed conditions of Himachal Pradesh.
- At Kangra, maize-green Frenchbean-potato gave highest system productivity of 29.26 and 29.15 t/ha and net returns Rs. 2,68,985 and 2,43,100/
ha under inorganic and integrated nutrient management system, respectively. Under organic management system, highest productivity (20.83 t/ha) and net returns (Rs. 51,032) were obtained in maize-french bean-garlic cropping system.

- Maize + soybean or maize + cowpea (green manuring) cropping system with recommended fertilizer application not only increased the maize grain yield by 19.6 and 32.5 per cent but at the same time leaves a residual effect on the succeeding gobhi sarson crop with yield advantage of 19.0 and 10.6 per cent, respectively over pure maize system.

- Grain yield of both maize and wheat remained statistically at par with the application of 100% recommended dose (RD) of NPK through chemical fertilizers and 50% RD of NPK through chemical fertilizers +50% RD of N through organic manures.

- Application of 100% RD of N through organic manures resulted in 36.8 and 11.9 per cent higher grain yield of maize and wheat as compared to farmers’ practice, respectively.

- Rice-potato-potato and rice-wheat-french bean gave highest paddy equivalent yield and net returns under irrigated agro-ecosystems of Una and Hamirpur districts, respectively.

- For row seeding of upland paddy under optimum soil moisture conditions, 60 kg seed/ha was adequate, whereas, for broadcast sowing 80 kg seed/ha of paddy was optimum.

- For the same date of nursery sowing of paddy both ICM (Integrated crop management) and SRI (system of rice intensification) were found promising and recorded 20 and 17 per cent higher grain yield over standard transplanting method, respectively. In varietal response to newer methods of transplanting (ICM & SRI) rice, HPR-2143 recorded significantly highest yield in ICM over transplanting method. However, cultivation of scented rice variety Kasturi due to its higher quality was found to be most remunerative.

- At Malan, dual purpose barley cultivar BHS-169 gave grain yield of 1440 kg/ha when it was cut for fodder purpose at 50 days after sowing, giving 1000 kg/ha of fodder additionally.

- Raised and sunken seed bed technology was most promising in diversifying rice farming under high rainfall conditions. Brinjal, lady’s finger and chillies on raised beds and low land rainfed rice in sunken beds were the best alternative in this endeavour.

- A dual-purpose barley cultivar BHS-365 produced maximum grain yield (2767 kg/ha) under rainfed conditions, which was significantly higher than BHS-169, HBL-276 and BHS-366. One cut of barley for green fodder at 50, 70 and 90 days after germination resulted in 35, 43 and 49 per cent reduction in grain yield as compared to no
cut treatment, however, the green fodder yield increased significantly with successive delay in cutting for fodder purpose.

- In Lahaul valley of Himachal Pradesh, capsicum and tomato were highly suitable cash crops compared to existing ones in mono-cropping system. Where as pea-summer squash and pea + carrot were the better options under double / intercropping systems.

- Under Network Project on organic farming, integrated nutrient management system resulted in better yields of cauliflower, cabbage, capsicum, radish, garlic and maize. Tomato-cauliflower-radish cropping system gave maximum return (Rs. 90,548/ha/annum) followed by maize-garlic (Rs.85,996/ha/annum). Tomato-cauliflower-radish cropping system gave maximum net return (Rs.1,93,570/ha/annum) and benefit:cost ratio (3.15) when supplied with rock phosphate enriched FYM + vermicompost in the ratio of 50:50.

- At Palampur, soybean variety PK-472 out yielded all other varieties. Surface drainage and ridge planting increased soybean seed yield by about 10.4 and 40.9 per cent compared to no surface drainage, respectively.

- Intercropping of wheat + linseed in row ratio of 4:4 and 6:4 produced significantly higher linseed equivalent yield compared to all other intercropping treatments.

**Fertility management**

- In a long term fertility experiment conducted at Badhiarkhar farm, significantly highest rice equivalent yield was obtained when 50% NPK (through fertilizers) + 50% N (through FYM) was applied to rice and 100% NPK (through fertilizers) to wheat in rice-wheat cropping system. Highest sustainability index was also recorded in the same treatment when worked out for the last 15 years.

- In a maize-wheat system, the integrated use of optimal dose of NPK and 10 t FYM/ha to maize crop gave better and more sustainable yields and also corrected the micronutrient and secondary nutrient deficiencies and soil acidity problems.

- Use of 100% N alone has deleterious effect on crop productivity. Exclusion of K in plant nutrition, however, has also resulted in drastic reduction in crop yields compared to balanced application of NPK. Declining trends in yields of maize and wheat with higher application of chemical fertilizers (150% NPK) was noticed because of emerging secondary nutrients’ deficiencies.

- The maximum productivity of 4210, 6620 and 3330 kg/ha of maize was recorded at Palampur, Bajaura and Dhaulakuan with the application of 150% NPK + 20 kg/ha ZnSO₄ (Table 7). The results made it amply clear that there is a need to have a fresh look at the existing application rates

### Table 7. Effect of site specific nutrient management on maize grain yield (kg/ha) and total uptake of N,P, K and Zn (Kharif 2006)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Grain yield (kg/ha)</th>
<th>Nutrient uptake (kg/ha)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers’ practice</td>
<td>2260</td>
<td>48.3</td>
<td>8.2</td>
<td>35.4</td>
<td>0.276</td>
</tr>
<tr>
<td>Farmers’ practice + ZnSO₄</td>
<td>2720</td>
<td>56.3</td>
<td>10.3</td>
<td>43.6</td>
<td>0.325</td>
</tr>
<tr>
<td>Recommended NPK</td>
<td>3820</td>
<td>70.8</td>
<td>14.2</td>
<td>60.0</td>
<td>0.434</td>
</tr>
<tr>
<td>Recommended NPK + ZnSO₄</td>
<td>4020</td>
<td>70.8</td>
<td>15.6</td>
<td>62.6</td>
<td>0.492</td>
</tr>
<tr>
<td>150 % NPK</td>
<td>3810</td>
<td>78.2</td>
<td>15.4</td>
<td>59.2</td>
<td>0.462</td>
</tr>
<tr>
<td>150 % NPK + ZnSO₄</td>
<td>4210</td>
<td>81.3</td>
<td>16.9</td>
<td>65.3</td>
<td>0.500</td>
</tr>
<tr>
<td>Recommendation of NPK on the basis of soil test</td>
<td>3540</td>
<td>66.0</td>
<td>13.3</td>
<td>55.2</td>
<td>0.416</td>
</tr>
<tr>
<td>Recommendation of NPK on the basis of soil test + ZnSO₄</td>
<td>3750</td>
<td>73.8</td>
<td>14.6</td>
<td>58.4</td>
<td>0.480</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>160</td>
<td>6.5</td>
<td>0.61</td>
<td>3.7</td>
<td>0.028</td>
</tr>
</tbody>
</table>
of N, P and K for maize crop grown in the above said locations.

- The significance of integrated plant nutrient system (IPNS) for sustained productivity vis-à-vis improved soil health is substantiated by 15 years of experimentation at Akrot (Una) whereby it has been established that application of 100% NPK + FYM produced significantly highest grain yield of maize as well as wheat compared to rest of the treatments. Application of 10 t FYM/ha in conjunction with 100 per cent of the recommended NPK to maize and 50 per cent of the recommended dose of NPK to french bean was found to be the best integrated nutrient management system in maize + french bean intercropping system under mid hill conditions.

- At Kangra, 50 per cent nutrient substitution in maize with FYM or vermicompost or their combination not only gave yield statistically at par with 100% inorganic nutrients but also left a residual effect on succeeding gobhi sarson crop with yield advantage of 4.5, 12 and 13 per cent, respectively.

- Addition of green manure @ 10 t/ha (fresh wt. basis) alongwith recommended NPK+ZnSO₄ @ 25 kg/ha increased the grain yield of rice significantly over recommended NPK+ZnSO₄.

- In varietal response to newer methods of transplanting (ICM & SRI), variety HPR-2143 gave highest grain yield of 7.14 t/ha using ICM. However, Kasturi due to its high quality was found to be more remunerative.

- Application of 50% NPK + FYM @ 5 t/ha 15 days before sowing (dry weight basis) with or without Azotobacter though was at par with 50% NPK + FYM incorporated just before sowing, resulted in significantly higher grain yield of upland paddy over farmers’ practice (FYM @ 5t/ha at sowing+35 kg N/ha applied 50 DAS).

- Application of 100 kg N + 120 kg K₂O alongwith 40 kg S, 5 kg borax and 20 kg ZnS0₄ gave highest equivalent yield in rice (PHB71, hybrid)– wheat (HPW-89) system.

- 50 % NPK (inorganic) + 50% N (FYM) + micro nutrient gave highest baby corn equivalent yield in baby corn-Chinese cabbage-onion crop sequence.

- Dual purpose (grains + fodder) wheat variety VL-829, comparable grain yields were recorded to no cut (2034 kg/ha), when the crop was supplied with 25 per cent higher N or 25 per cent higher seed or both and this gave an additional fodder yield varying from 3900 to 4600 kg/ha.

- Application of NPK along with 25 kg/ha ZnSO₄ remained the best treatment combination for higher grain yield of wheat under mid hill conditions.

- In Lahaul valley, in pea + carrot intercropping system, application of either 2.5 t FYM/ha + Rhizobium or 5 t FYM /ha gave significantly higher pea equivalent yield. The former treatment also gave the highest net returns of Rs. 1,41,633/ha (Table 8).

- The application of NP nutrients through DAP along with 80 kg/ha mineral gypsum was found best management practice for realizing higher productivity of vegetable pea and garlic.

- Cauliflower-cauliflower-pea cropping sequence recorded highest net returns (B:C 2.04) with integrated plant nutrient system in Mandi area, whereas, in Kullu area, the most remunerative cropping systems were cauliflower-cauliflower-cauliflower (B:C 1.34) and french bean-cauliflower-cauliflower (B:C 1.22).

- Newly developed IPNS based fertilizer adjustment equations for soybean, maize and wheat as given above worked reasonably well up to the targets of 3.0, 5.0 and 4.0 t/ha, respectively.

- Seed inoculation with phospho-bacteria culture can help to meet out about 20 kg of P₂O₅/ha requirement.

- It has been established that yield levels in potato obtained under 100% NPK + 12.5 t VC/ha were comparable with that under 100% NPK + 12.5 t FYM/ha.
Table 8. Effect of organic/biofertilizers and NPK levels on productivity of pea + carrot intercropping system

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Yield (t/ha)</th>
<th>PEY (t/ha)</th>
<th>System productivity (kg/ha/day)</th>
<th>Net returns (Rs./ha)</th>
<th>B:C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pea</td>
<td>Carrot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Organic /Biofertilizer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FYM 5 t/ha</td>
<td>11.35</td>
<td>8.93</td>
<td>15.81</td>
<td>87</td>
<td>136738</td>
</tr>
<tr>
<td>Rhizobium</td>
<td>10.79</td>
<td>8.16</td>
<td>14.87</td>
<td>81</td>
<td>131123</td>
</tr>
<tr>
<td>PSB</td>
<td>10.39</td>
<td>8.60</td>
<td>14.69</td>
<td>80</td>
<td>128848</td>
</tr>
<tr>
<td>FYM 2.5 t/ha + Rhizobium</td>
<td>11.59</td>
<td>8.53</td>
<td>15.85</td>
<td>87</td>
<td>141633</td>
</tr>
<tr>
<td>FYM 2.5 t/ha + PSB</td>
<td>10.86</td>
<td>9.04</td>
<td>15.38</td>
<td>84</td>
<td>135788</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>0.31</td>
<td>0.39</td>
<td>0.38</td>
<td>2</td>
<td>4570</td>
</tr>
<tr>
<td><strong>NPK level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 %</td>
<td>7.49</td>
<td>6.86</td>
<td>10.92</td>
<td>60</td>
<td>82227</td>
</tr>
<tr>
<td>100 %</td>
<td>12.34</td>
<td>8.73</td>
<td>16.70</td>
<td>92</td>
<td>151618</td>
</tr>
<tr>
<td>150 %</td>
<td>13.15</td>
<td>10.37</td>
<td>18.34</td>
<td>100</td>
<td>170633</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>0.33</td>
<td>0.43</td>
<td>0.36</td>
<td>20</td>
<td>4365</td>
</tr>
</tbody>
</table>

PEY = pea equivalent yield

- The water use efficiency was highest in CTR (4.11 kg/ha-mm), followed by SRI-late (3.54 kg/ha-mm) and SRI-timely (3.21 kg/ha-mm). Surface drainage and ridge planting increased soybean grain yield by 10.4 and 40.9 per cent, respectively, compared to no surface drainage. Zero tillage resulted in significantly lowest grain yield, which was lower by 9.9 and 7.4 per cent as compared to conventional and conservation tillage, respectively. Maximum yield was obtained with sprinkler irrigation which produced 1.15, 1.23 and 1.34 times higher curd yields compared to drip, pitcher and garden pipe methods of irrigation. The application of waste bio-mass @ 10 t/ha significantly benefited both broccoli and french bean. The highest broccoli yield (12.91 t/ha) was obtained from the treatment where 2 cm depth of irrigation was applied for the first 30 days and 4 cm thereafter.

- The productivity of french bean and pea in plots receiving organic manures/bio-fertilizers continuously for three years was almost comparable with the productivity level observed with the application of mineral fertilizers. About 50% nitrogen and phosphorus could be substituted with the use of organic manures and bio-fertilizers continuously for three years without any loss to yield. The application of bio-fertilizers (nitrogen fixers and phosphate solublizers) along with 10 t FYM/ha has added advantage in increasing the productivity of tomato, onion and brinjal as compared with the application of 30 kg N/ha and 10 t FYM/ha.

- The cultivated lands of Awa watershed comprising 150 km² in district Kangra, HP were surveyed on 1:10,000 scale and classified as per land capability. The soils have medium to fine texture and taxonomically classified as Inceptisol, Alfisol and gravely coarse textured Entisols. These lands were put under capability class II, III, IV and VI.

- Knotting of leaves one month prior to harvesting and spray of maleic hydrazide at concentration of 2000 ppm two weeks prior to harvesting along with removal of leaves after curing (1 week) under shade resulted in minimum weight loss of garlic bulbs along with minimum incidence of rotting/drying/sprouting in storage.

- Application of 20 tonnes vermicompost/ha + 100% NPK + biofertilizer (seedling dip/seed inoculation) gave maximum yield in okra (4.8 t/ha), cauliflower (20.7 t/ha) and french bean
(12.1 t/ha) which was at par with recommended practice.

- In sprouting broccoli, application of 20 t FYM/ha in combination with recommended dose of NPK gave the highest yield.

- Four levels of phosphorus alongwith three dates of sowing were tried to find out their response on seed yield of mash. The result indicated consistent and significant increase in seed yield of mash upto 40 kg P$_2$O$_5$/ha.

- Maximum onion bulb yield (27.3 t/ha) was recorded in plots receiving 100 kg P$_2$O$_5$/ha along with 800 kg lime/ha (1/5th of lime requirement in furrows). The residual effect of phosphorus and lime applied to previous onion crop was studied in the succeeding soybean. Soybean grain yield increased significantly with phosphorus upto 100 kg P$_2$O$_5$/ha. Maximum soybean grain yield (2240 kg/ha) was recorded in plots receiving 100 kg P$_2$O$_5$/ha along with 400 kg lime/ha (1/10th of lime requirement in furrows) and was comparable with the yield levels obtained with 75 kg P$_2$O$_5$/ha along with 800 kg lime/ha.

- Application of recommended NPK + FYM @ 10 t/ha outperformed in both rice and onion. In case of onion, application of vermicompost @ 7.5 t/ha along with green manuring + biofertilizer + vermiwash produced the bulb yield equivalent to recommended NPK + FYM.

- Dhaincha + 50%N + compost and sunnhemp + 50%N + compost were found to be the best treatments in increasing the total biological, grain and straw yield in a rice–wheat cropping sequence.

- Application of sulphur @ 40 kg S/ha along with NPK increased the percentage of A- grade bulbs and the onion bulb yield significantly and consistently.

- Under late sown mid hill conditions *B. carinata* variety BCRS-17 gave the highest mean seed yield (2437 kg/ha) and this was 72-77% and 56 % higher than *B. napus* and *B. juncea* cultivars evaluated (Table 9). All the varieties responded to higher level of fertility (125 % of recommended) and the increase over recommended was 17.1 per cent.

- Seeds of gladiolus cv. Dhanvantri were successfully grown to get new variants. Carnation and Alstromeria were successfully grown in the green house for cut flowers production.

**Forage and grassland management**

- Application of biofertilizers i.e. *Azotobacter to setaria* and *Rhizobium* to white clover resulted in a significant improvement in herbage yield of setaria + white clover cropping system over control. Use of biofertilizers increased the herbage yield of both the crops at each level of inorganic fertilizers. Highest herbage yield was produced with the application of 100% NPK. Highest net returns of Rs. 34094/ha were obtained with 75% NPK through inorganic + biofertilizers (Table 10).

- Introduction of a combination of grasses + legumes in 1:1 row ratio was found to be very effective in suppressing the existing local grass species in natural pasture lands under dry temperate conditions. Mixture of orchard grass + lucerne gave green and dry forage yields of 43.88 and 14.35 t/ha, respectively, which were comparable to orchard grass + red clover.

- Use of pre plant herbicide in planting methods proved to be very effective than other methods. It gave 9.50 and 9.22 per cent more green and dry forage yield compared to scrapping the soil surface method. Crude protein per cent was also improved with the use of the herbicide.

**Agricultural Meteorology**

- Studies on climate change suggest that a significant rise of the order of 1°C (1.5°C in Rabi and 0.4°C in Kharif) in annual mean temperature was observed in Palampur region. Rainfall showed an unprecedented decrease of 1365 mm annually (938 mm in Kharif alone) over the past 31 years upto 2005. Evaporation has been decreasing at 2.6 mm/annum and RH is increasing at 0.5 mm annually.
The validation for medium range weather forecast done at Palampur indicated that rainfall forecast was 83% correct in all seasons except South-West monsoon with 59 per cent correct. Higher rainfall amount was predicted for winter season and low in Kharif season.

C. Crop Protection

Insect-pests

• The population of rice hispa was found to be very severe in some areas at village Khawala, Trind and Dhanotu. The damage varied from 50-90 per cent during July-August. Sporadic infestation of scarabaeid beetle, *Popillia lucida* Newman was observed on paddy at some places in Kangra and Una districts.

• In paddy, for the control of leaf folder, hispa and whorl maggot, chlorpyriphos 10G (1000 g a.i./ha) and carbofuran 3G (1000 g a.i./ha) were found effective. Among the foliar applications, monocrotophos (500 g a.i./ha) was the most effective against rice hispa and whorl maggot whereas spinosad 45 SC (56 g a.i./ha) was found effective for the control of leaf folder.

### Table 9. Performance of some promising varieties of rapeseed-mustard under rainfed late sown conditions at different fertility levels

<table>
<thead>
<tr>
<th>Varieties</th>
<th>2005-06</th>
<th>2006-07</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCRS-17</td>
<td>2685</td>
<td>2189</td>
<td>2437</td>
</tr>
<tr>
<td>OMK-2</td>
<td>1620</td>
<td>1504</td>
<td>1562</td>
</tr>
<tr>
<td>ONK-1</td>
<td>1574</td>
<td>1259</td>
<td>1416</td>
</tr>
<tr>
<td>Neelam</td>
<td>1643</td>
<td>1111</td>
<td>1377</td>
</tr>
<tr>
<td>CD(P=0.05)</td>
<td>488.9</td>
<td>220</td>
<td></td>
</tr>
</tbody>
</table>

### Fertility levels

- 75% of recommended: 1337, 1180, 1285
- 100% Recommended: 1944, 1590, 1767
- 125% of recommended: 2361, 1777, 2069
- CD(P=0.05): 311.5, 190

### Table 10. Effect of integrated nutrient management on the yield and economics of setaria-white clover system

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Setaria + clover</th>
<th>Net returns</th>
<th>B:C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green (t/ha)</td>
<td>20.62</td>
<td>3.77</td>
<td>12093</td>
</tr>
<tr>
<td>Dry (t/ha)</td>
<td>28.59</td>
<td>5.31</td>
<td>17842</td>
</tr>
<tr>
<td>Biofertilizers (<em>Azotobacter/Rhizobium</em>)</td>
<td>36.06</td>
<td>6.75</td>
<td>19638</td>
</tr>
<tr>
<td>50% through inorganic fertilizer</td>
<td>44.86</td>
<td>8.17</td>
<td>26341</td>
</tr>
<tr>
<td>Biofertilizers (<em>Azotobacter/Rhizobium</em>) + 50% through inorganic fertilizer</td>
<td>52.24</td>
<td>9.48</td>
<td>30741</td>
</tr>
<tr>
<td>75% NPK through inorganic fertilizer</td>
<td>56.77</td>
<td>10.25</td>
<td>34094</td>
</tr>
<tr>
<td>Biofertilizers (<em>Azotobacter/Rhizobium</em>) + 75% through inorganic fertilizer</td>
<td>59.85</td>
<td>10.91</td>
<td>32844</td>
</tr>
<tr>
<td>100% NPK through inorganic fertilizer</td>
<td>1.02</td>
<td>0.16</td>
<td>-</td>
</tr>
<tr>
<td>SEm ±</td>
<td>3.15</td>
<td>0.50</td>
<td>-</td>
</tr>
</tbody>
</table>

- The population of rice hispa was found to be very severe in some areas at village Khawala, Trind and Dhanotu. The damage varied from 50-90 per cent during July-August. Sporadic infestation of scarabaeid beetle, *Popillia lucida* Newman was observed on paddy at some places in Kangra and Una districts.

- In paddy, for the control of leaf folder, hispa and whorl maggot, chlorpyriphos 10G (1000 g a.i./ha) and carbofuran 3G (1000 g a.i./ha) were found effective. Among the foliar applications, monocrotophos (500 g a.i./ha) was the most effective against rice hispa and whorl maggot whereas spinosad 45 SC (56 g a.i./ha) was found effective for the control of leaf folder.

Paddy crop infested with rice hispa
• Seed treatment with imidacloprid 17.8 SL @ 3ml/kg followed by application of triazophos (0.04%) and cypermethrin (0.0075%) was highly effective against whitefly, bean bug and blister beetle in urdbean at Berthin and Palampur. For the control of pulse beetle infesting mash, foliar application of cypermethrin (0.0075%) at pod formation (45 days after germination) was most effective at Bajaura.

• For the management of whitegrubs in pea in the dry temperate areas of the state, seed treatment with thiamethoxam 70 WS (2 g/kg) resulted in minimum plant mortality (7.96 %) being statistically superior to others except imidacloprid @ 5 g/kg (9.35 %). Highest pod yield (7811 kg/ha) was recorded in seed treatment with thiamethoxam @ 2g/kg (Table 11).

• Among different spray schedules evaluated for the integrated management of fruit borer and buckeye rot disease in tomato, a spray schedule consisting of three applications of SAAF (0.25%) + endosulfan (0.05%) at flower initiation stage, followed by the spray of Score (0.05%) + endosulfan (0.05%) after 15 days of the first spray, and third spray with Antracol (0.3%) after 15 days of second spray was found to be the most effective.

• Against cabbage butterfly, Pieris brassicae on cabbage, two spray of Beauveria bassiana (Daman) @ 1000g/acre + cypermethrin (0.00375%) at 15 days interval were most effective.

• Out of nine treatments applied at three locations, endosulfan (0.05%), lambda-cyhalothrin (0.004%), Trichogramma bactrae @ 25000 adults/ha + Econeem (3ml/lit) proved effective against Plutella xylostella infesting cole crops.

• A new isolate of PbGV has been found infesting Pieris brassicae in Kangra area. Two more baculoviruses have been isolated from Agrotis ipsilon and Plusia species.

• For organic vegetable production, 10% aqueous leaf extract of ‘Karvi’ and ‘Bhang’ (Cannabis sativa), were found to be the most effective and economical treatments to control tomato fruit borer. Whereas, aqueous extract of Kaner (Nerium sp.) leaves and Darek (Melia azaderach) @ 10%, sprayed at an interval of 10 days, was found to be the most effective against cabbage butterfly in cauliflower. These treatments were at par with bioinsecticide, Bacillus thuringiensis var kurstaki (Dipel) @1.0 kg/ha in the effectiveness.

• Against potato tuber moth, spinosad (0.0024%) was found effective under field conditions. In potato stores, spinosad @ 50 ml/ton of tubers also proved effective up to three months of storage.

• To control rhizome fly, Calobata indica in ginger,

Table 11. Efficacy of different treatments against whitegrubs in pea (var. Azad P 1)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Dose</th>
<th>% plant mortality due to whitegrubs (45 DAS)</th>
<th>Green pod yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imidacloprid 70 WS (ST)</td>
<td>5 g/kg seed</td>
<td>9.35</td>
<td>7045</td>
</tr>
<tr>
<td>Thiamethoxam 70 WS (ST)</td>
<td>2 g/kg seed</td>
<td>7.96</td>
<td>7811</td>
</tr>
<tr>
<td>Chlorpyrifos 20 EC (ST)</td>
<td>4 ml/kg seed</td>
<td>11.04</td>
<td>6033</td>
</tr>
<tr>
<td>Quinalphos 25 EC (ST)</td>
<td>4 ml/kg seed</td>
<td>10.35</td>
<td>5295</td>
</tr>
<tr>
<td>Lindane 20 EC (ST)</td>
<td>4 ml/kg seed</td>
<td>12.40</td>
<td>4041</td>
</tr>
<tr>
<td>Chlorpyrifos 20 EC (SA)</td>
<td>800 g a.i./ha</td>
<td>14.80</td>
<td>5017</td>
</tr>
<tr>
<td>Quinalphos 25 EC (SA)</td>
<td>800 g a.i./ha</td>
<td>11.70</td>
<td>5077</td>
</tr>
<tr>
<td>Lindane 20 EC (SA)</td>
<td>800 g a.i./ha</td>
<td>13.33</td>
<td>4522</td>
</tr>
<tr>
<td>Thiamethoxam 25 WG (SA)</td>
<td>800 g a.i./ha</td>
<td>13.56</td>
<td>5042</td>
</tr>
<tr>
<td>Artemisia leaf powder</td>
<td>500 kg/ha</td>
<td>15.50</td>
<td>3922</td>
</tr>
<tr>
<td>Untreated control</td>
<td>-</td>
<td>19.70</td>
<td>3710</td>
</tr>
<tr>
<td>CD (P= 0.05)</td>
<td></td>
<td>1.61</td>
<td>243</td>
</tr>
</tbody>
</table>
application of Super 505 (chlorpyriphos 50% +
cypermethrin 5%) @ 1.5 ml/lit after one month of
sowing gave best control with minimum maggots
(1.0) per rhizome as compared to 9.6 maggots in
untreated check.

• Against tea mealy bug, CHA 2062 @14.4 g a.i./ha
was highly effective causing 98 per cent reduction
in infestation. Agrospray T oil @ 0.05% was most
effective against mites and the reduction was 99
per cent. 100 per cent reduction in leaf punctures
of tea mosquito bug was obtained with Calypso
@ 30 g a.i./ha.

• Biodiversity of scarabaeid beetles of Himachal
Pradesh revealed that Brahmina coriacea,
Holotrichia longipennis, Phylognathus dionysius,
Lepidiota stigma and Anomala dimidiata were
predominant species. However, Brahmina
flavoserica was the predominant species at
high altitudes viz. Janjehli, Manali and Barot.
Lepidiota stigma has been recorded as a new pest
threatening maize cultivation in lower river bed
areas.

• On cabbage and cauliflower, spinosad residues
dissipated below detectable limits at 17.5 and 35 g
a.i./ha within 7 and 10 days of spray, respectively.
In tea, CHA 2062 @14.4 g a.i./ha dissipated
below maximum residue limit (MRL) within one
day of spray in/on tea leaves.

• Under AICRP on Plant Parasitic Nematodes, more
than 45 polyhouses in Himachal Pradesh were
surveyed for nematode infestation. Root knot
nematode was found to be the most devastating
and has resulted in failure of carnation crop in
some polyhouses in district Bilaspur. In paddy
fields, the losses due to root knot nematodes,
Meloidogyne graminicola were estimated to the
extent of 8 per cent.

Diseases

• The incidence/severity of rice blast during
Kharif was low to medium in the state with few
exceptions. Rice seed samples collected from
three districts (Kangra, Mandi & Kullu) had
no rice bunt; however, false smut was found
in traces. Out of thirty five entries in the NSN
(Hills), entries HPR-2001-GH5; HPR-2501; HPR
2504; VL Dhan 61 were found to be resistant to
both leaf & neck blast. Out of 56 entries in Donor
Screening Nursery TNRH 142 R, TNRH 145-H,
HPR 2529, HPR 2530, VL 30018, VL 10036, VL
4040 and VOPH-3102 were found to be resistant
to both leaf and neck blast.

• In the hybrid rice screening nursery with forty
eight entries IET No. 19725; 19734; 19740;
19743 & 19760 were found to be highly resistant
(1 score) to leaf blast.

• Amongst the five new fungicides evaluated
against leaf and neck blast, three sprays of Gain
75WP 0.6g/litre proved highly effective. In
evaluation of combination products, four sprays
of Tricyclazole + Mancozeb 80 WP @ 2.5 g/litre
of water proved most effective against leaf and
neck blast and gave significantly higher yield as
compared to unsprayed checks.

• Among six bio-pesticides evaluated against rice
blast, four applications of bio-pesticide Trichozen-
T when applied to soil @ 5 kg/ha was found most
effective against leaf blast whereas biotos @ 2.5
ml/litre of water was observed as most effective
against neck blast.

• Native 75 WG (Trifloxystrobin 25% +
Tebuconazole 50%) a new fungicide was found
best in controlling both leaf and neck blast of rice,
as well as grain infection at all the concentrations
(25+50, 37.5+75 and 50+100 g.a.i./lit) tested and
also improved the grain yield as compared to
control.

• Two sprays of Tilt @ 0.1% after 45 and 60 days of
transplanting were found highly effective against
brown leaf spot of paddy.

• Sudden wilt of sponge gourd is the most serious
disease causing even 100 percent loss in some
cases particularly in Kangra, Hamirpur, Una and
Bilaspur districts of Himachal Pradesh. One spray
of Sevin 2g/lit immediately after germination
or after transplanting seedlings from polytubes
followed by regular sprays of Roket (1 ml/lit) +
Bacterinashak (0.3 g/lit) followed by endosulfan (2 ml/lit) + Bacterinashak (0.3 g/lit) and Sevin (2 g/lit) + Bacterinashak (0.3 g/lit) starting from the initiation of flowering at 15 days interval managed the disease by 60-80 per cent.

- Three Ascochyta populations comprising of 37 isolates causing pea blight were studied to know the genetic diversity and probable rate of spread of pathotypes. The genetic diversity amongst the pathogen populations was calculated on the basis of allele frequencies of 13 random amplified polymorphic DNA markers. Isolates of Ascochyta spp. were scored for variation at 13 putative random amplified polymorphic DNA (RAPD) loci. Allele frequency at single locus varied from 0.00 to 1.00. Diversity within each population (HS) was high with values ranging from 0.36 to 0.40. Significant genetic differentiation was detected among all three subpopulations indicating less distance gene flow. Haplotype diversity in three populations was 0.57 (Sangla), 0.53 (Jinjhali) and 0.54 (Chamba). The 37 isolates were categorized into two major clusters accommodating 18 and 19 pathogen isolates.

- Raxil @ 2 g followed by carbendazim @ 2.5 g and F-100 @ 3.5 g/kg seed were found effective in managing root rot/wilt complex of pea and also improved the yield. Seed treatment of pea with bio-control agent *T. harzianum* @ 5g/kg and one foliar spray of Bavistin @ 0.1% gave significant control of root rot complex and foliar disease of pea.

- Soil drenching before transplanting along with seedling dip in Panchgavya was found highly effective against collar rot of tomato caused by *Sclerotium rolfsii*.

- Aqueous extract of dried rhizomes of *Acorus calamus* (Barain), has strong antifungal activity against two soil-borne pathogens viz; *Rhizoctonia solani* and *Sclerotium rolfsii*.

- Eighteen botanicals along with five neem based formulations and nine plant essential oils were evaluated *in vitro* and *in vivo* against tomato, brinjal and capsicum isolates of *R. solanacearum*. Irrespective of the method of evaluation and the isolates used, the aqueous and organic extract of neem, in general, was found to be most inhibitory at 100 per cent concentration followed by *Ranunculus muricatus* and *Ageratum houstonianum* against all the three isolates.

- Rock phosphate as one of the component comparatively showed less bacterial wilt incidence in tomato and capsicum.

- Vermicompost, biodynamic compost, and Agnihotra ash were found effective in controlling the diseases of maize and soybean grown in the organic farm.

- Two sprays of Antracol @ 0.25% were found effective against early blight of potato.

- Wheat genotypes namely; HPW 233, DDK 1025, TL 2942, TL 2949 and LOK 54 were found highly resistant to Karnal bunt at Dhaulakuan. However, two genotypes TL 2942 (T) and JKW 20 showed multiple disease resistance.

- Two sprays of Ecoderma (*T. viride*) @ 5g/litre at flag leaf stage and 50% ear head emergence stage gave 89 per cent control of Karnal bunt of wheat. However, one spray of Ecoderma followed by another spray of Tilt resulted complete control of the same.

- Two foliar sprays of Folicur @0.1% were found highly effective against Karnal bunt. Seed dressing fungicides F100 @ 3.5g/kg seed treatment was found effective against loose smut and Karnal bunt of wheat.

- Carboxin @ 2.5 g, carbendazim @ 2.0 g and F-100 @ 3.5 g/kg of seed were most effective in controlling loose smut of wheat.

- Three sprays of fungicide score 25EC @ 0.05% and Kavach @ 0.25% was highly effective in reducing the incidence of Phyllosticta leaf spot and increasing the yield of ginger.

- Out of 250 hybrid and composite stocks of advanced breeding material of maize, twenty five stocks DMR-417, 425, 427, 430, 432, 452, 455,
458, 462, 466, 467, 471, 475, 479, 480, 481, 486, 489, 490, 491, 494, 810, 807, 808, 890 showed multiple disease resistance against Erwinia stalk rot, brown stripe downy mildew and Maydis leaf blight diseases.

- Out of six bioagents tested, *Trichoderma harzianum* (SMA-4) and *T. koningii* (DMA-8) were found to be very effective against *S. rofissi* (soybean root rot) and *Drechslera maydis* (maydis blight of maize) resulting in 84.2 to 87.1 per cent mycelial inhibition, respectively.

- Among the promising field peas, germplasm genotypes IPFD 2-6, Pant P-25, HUDP 28, HUDP 27 were resistant to pea rust. Lines KPMR 708, DMR 7, EC 389377 of field peas were resistant to Ascochyta blight and downy mildew.

- Genotypes of lentil L6-386, 387, 390, 401, (IVT small seeded and extra large seeded) and L 1, 12, 3134, 46, 50 (PPSN, IIPR, Kanpur) were highly resistant to rust and Ascochyta blight. Fungicides Tilt, Contaf 5EC, @ 0.1% and score 0.05% were highly effective for reducing the rust severity and increasing yield in lentil.

- Entries of chickpea ABN 2,3,4,6,7,8,9, Himachal Chana-I and II, IGL 1, AGD 6 (PPSN 2006-07), C 111, 112, 121, 123, 105 and 107 (IVT), ICCV 98818, EC 516796, 516729, 516791, EC 516709, 516771, ICC 6301, ICCV 04530 (IABN) were resistant to Ascochyta blight. Out of 28 entries (9 Kabuli and 19 desi type) tested at Sundernagar, ICCV-16, ICCV-95413, ICCV-96903, ICCV-8927, DKG-101, DKG-103, DKG-108 and DKG-112 remained free from Ascochyta blight.

- Score 0.05% and Kavach @ 25% were highly effective for the management of Ascochyta blight of chickpea.

- Lines KU6 368, KU7, 59, KU 102, 154, P 711 of mash were resistant to MYMV. Genotype of mash P-720 was highly resistant to powdery mildew and P 715, 716, KU 356, KU 311, KU 7 were resistant. Lines KM6 205, 210, 212, 214, 216, 217, 219, 220, 230, 231, P 601, 605, 606, 608, 619 of moong were free from MYMV. Genotype KM6-2101 of moong was free from anthracnose and genotypes KM6 217, 219, 220 showed multiple resistance to MYMV and anthracnose.

- 126 entries of rapeseed-mustard comprising of materials from advance varietal trials and other promising germplasm lines were screened against Alternaria blight and white rust diseases in different nurseries at Kangra. Rapeseed-mustard entries NRCDR-513, NRCHB-04-06, NDWR-05-1, JMM-18, JM-1 and BIOYSR were found resistant to white rust.

- About 505 accessions of linseed were screened against prevailing diseases like rust and bud blight under severe epiphytotic conditions at Kangra. Entries like RLC-112, JLS-9, Padmini, Parvati and Sheela were found to be highly resistant to rust and moderately resistant to bud blight.

- Three foliar sprays of fungicides Tilt 25EC, Contaf 5EC @ 0.1% and score 0.05% were highly effective in reducing leaf and pod infection of Alternaria leaf blight and increasing the yield in mustard variety Varuna.

- Three sprays of Difenconazole (Score, 0.05%) were found most effective for the control of Alternaria blight in rapeseed-mustard.

- Severity of white rust on leaves and staghead formation was significantly low (12.7 and 0.2%) in crop sown on Oct.25 in comparison to Nov.15 sown crop (22.9 and 1.4%). Lowest severity of white rust on leaves (5.3%) and stagheads (0.1%) was observed when seed treatments with Apron 35 SD (6g/kg seed) along with 2 sprays of Indofil M-45(0.2%) were applied.

- Propiconazole (0.1%) provided effective control of rust and bud blight diseases in linseed.

- VLS 63 and VLS 47 lines of soybean were found resistant to pod blight and moderately resistant to target spot disease. Pod blight incidence on Bragg and Shivalik was low when it was sown in 1st week of July as compared to last week of June.

- The coat protein gene of two strains (NL1 & NL1n) of BCMV has been cloned, sequenced
and submitted to gene bank vide accession No. EF036693 and EF 036694. Four strains of BCMV have been established in Himachal Pradesh and different sources of resistance have been identified.

- Four common bean cultivars possessing resistance against different strains of BCMV have a single dominant (Hans and Contender) and recessive (KRC 22 and KRC-4) resistance gene.

**Weeds**

- Tank mix application of clodinofop 60 g + carfentrazone 10 g/ha or clodinofop 60 g + metsulfuron methyl 3 g/ha and sequential application of clodinofop followed by (fb) 2,4-D or metsulfuron or carfentrazone were equally effective to control weeds and increase grain yield of wheat.
- In transplanted rice-wheat system, herbicide rotation in both the crops and 100 per cent N through fertilizer or continuous use of single herbicide in rice with 75% N through fertilizer and 25% N through Lantana and herbicide rotation in wheat resulted in effective control of weeds and higher grain yield of both the crops.
- In maize-wheat sequence, zero tillage in maize and conventional tillage in wheat in combination with atrazine in maize and clodinofop 60 g/ha fb 2, 4-D 1.0 kg/ha in wheat increased the grain yield of both the crops.
- For control of weeds in raised seed bed planted blackgram with particular reference to Ageratum, application of metolachlor 1.5 kg/ha (pre) or imazethapyr 0.10 kg/ha resulted in effective control of weeds and increase in seed yield.
- Continuous application of butachlor in transplanted rice and isoproturon 1.5 kg/ha in wheat for last 13 years neither leave their detectable residues in soil nor affect the chemical properties of the soil.
- Drum seeding of rice in combination with cyhalofopbutyl 90 g/ha (20 DAS) resulted in higher grain yield by effective control of weeds over broadcast method in integration with butachlor 1.5 kg/ha.
- In brinjal-pea cropping system, soil solarization in integration with pendimethalin 0.6 kg/ha+1HW in brinjal and direct application of pendimethalin 0.6 kg/ha (pre) + 1 HW in pea resulted in significantly higher fruit yield of both the crops by effective control of weeds.
- To control weeds in soybean, haloxyfopmethyl 100 g/ha or trifluralin 1.5 kg/ha (pre) or Quizalofop ethyl 62.5 g/ha (post) were found to be equally effective.
- Post emergence application of clodinofop at 80 g/ha + 2, 4-D @ 0.5 kg/ha resulted in significant reduction in weed dry weight and weed count and highest yield of linseed.
- Three cuttings at monthly or two cuttings at two months interval starting from 1st August are effective to exhaust the food material of Eupatorium completely.
- Pea crop responded significantly upto 60 kg P$_2$O$_5$/ha when weeds were controlled through pendimethalin + HW and the crop was sown in raised bed.
- In onion, application of herbicides, Alachlor @ 1.0 kg/ha + hand weeding or Alachlor @ 1.5 kg/ha or Pendimethalin @ 1.2 kg/ha significantly reduced weed dry matter and increased the yield significantly over their low doses without hand-weeding. These treatments were at par with hand weeding.

**D. Mushrooms and Apiculture**

- Out of 188 fleshy fungi mother cultures five culture extracts have been found to possess anti-dementia activity. Culture No. F HKV-IHB 652 MB has been found to be active for the anti-dementia and anti-parkinsonian activity whereas culture No. F HKV-IHB 658 MB has been found to possess activity against dementia, depression and anxiety in in vitro screening at ITRC, Lucknow.
- Among the wild collections of mushrooms made from various localities of Himachal Pradesh, a
A wild strain of *Pleurotus eryngii* was cultivated on paddy, soybean and mash straw following standard technique under mushroom house conditions with temperature ranging from 20-25°C.

- Five wild *Pleurotus* spp. were analyzed for the presence of polysaccharides (based on their monomer forms) and amino acids. Thin layer chromatography (TLC) results of polysaccharide analyses revealed that *P. sajor caju*, *florida*, and *flabellatus* contain polysaccharides in the form of their monomers whereas, these polysaccharides could not be detected in *P. sapidus*. Whereas, amino acid analyses showed the presence of alanine, glutamine, aspartagine, lysine and proline in all the tested species of *Pleurotus*.

- Rat feeding experiments with the wild isolates of *Pleurotus* showed that inclusion of *Pleurotus* spp. at 5% or 10% level had no significant effect on gain in body weight. The blood plasma profile of the rats showed that feeding of 5% of *P. florida* and *P. ostreatus* reduced the cholesterol and BUN (Blood Urea Nitrogen) levels significantly as compared to control treatment. There was decrease in Creatinine and bilirubin with all the species of *Pleurotus* as compared to control but uric acid levels were not controlled by either of *Pleurotus* spp.

- Spent mushroom substrate was used for preparing vermicompost using *Eudrilus eugeniae* species of earthworms using surface bed method. Vermicompost analysed for major plant nutrients revealed that all the three essential nutrients NPK in the spent mushroom compost increased after vermicomposting.

- More than 35 specimens of wild and edible macro fungi from Lahaul valley were collected and identified for the first time belonging to species of *Lactarius*, *Laetiporus*, *Laccaria*, *Stropharia*, *Marasmius*, *Cortinarius*, *Ramaria*, *Russula* and *Strobilomyces*.

- Pure cultures of locally available wild and edible *Laetiporus* sp. of Lahaul valley were prepared. Different types of grain substrates were evaluated for spawn making and it was observed that buckwheat supported profuse mycelial growth. Various economically viable and cheap domestic wastes have been identified to standardize as substrate for cultivation of button mushroom (*Agaricus bisporus*), dhingri and locally available edible polypore in the valley.

- Successful attempts have been made to introduce cultivation of button mushroom (*Agaricus bisporus*) and dhingri (*Pleurotus sajor-caju*) in the tribal areas of Lahaul. Compost bags for trial were kept indoors in farmers’ house at different locations where farmers harvested a good crop of button mushroom.

- At BRS, Nagrota, 132 colonies were maintained and 233.5 kg of honey was extracted. Stock of 40 *Apis mellifera* colonies was maintained at Dhaulakuan and all the colonies were found to be infested by mite, *Varroa destructor*.

- Fumigation of *A. mellifera* colonies with formic acid 85 % @ 3-5 ml/colony/day for 21 days and oxalic acid 3% sprayed on bees @ 5ml/colony thrice at an interval of 10 days were found effective for *Varroa* management. Under the programme on Task Force on beekeeping, 5 farmers adopted beekeeping and 3 are functioning as migratory beekeepers.

- *Apis cerana* and *Eupeodes frequens* were found to be the important and efficient pollinators of radish. *A. cerana* started working in the morning as early as 0718+ 0010 hrs and worked for 10 hours and 41 minutes in a day. The working duration for *E. frequens* was 10 hours and 25 minutes.

### E. Biotechnology

- In a study on development of micronutrient enriched maize through molecular breeding, Fe and Zn contents in the kernels of 100 inbred lines of maize obtained from CIMMYT, Mexico; HAREC, Bajaura; DMR, New Delhi; Harvest Plus; IARI, New Delhi; and VPKAS, Almora were estimated. The genotypes, CM-122 (66.97 mg/kg), HP-35-6 (50.86 mg/kg), IML-119 (49.57 mg/kg), were evaluated.
mg/kg), IML-205 (49.12 mg/kg), IML-289 (48.68 mg/kg) and CM-355 (46.51 mg/kg) had high Fe content. The highest Zn content was found in IML-289 (35.83 mg/kg) followed by HPKP-12 (31.69 mg/kg), HP-35-6 (29.02 mg/kg), HPKP-1 (27.24 mg/kg) and IML-119 (25.77 mg/kg). Genotype HP-35-6 has high kernel-Fe (50.86 mg/kg) as well as high kernel-Zn (29.02 mg/kg) content. There was significant correlation between kernel-Fe and kernel-Zn contents (r = 0.395, P ≤ 0.01). Bioinformatics tools were used to identify Fe and Zn transporter candidate genes. A total of 22 SSR loci were identified in the candidate gene sequences for zinc and iron transporters. Five of the SSR markers, viz., AZM5_16199, AZM5_13741, AZM5_91540, AZM5_89415, AZM5_17530 showed polymorphism.

• A new rice blast resistance gene [Pi-t(f)] was mapped from a DH derivative of cross HPU-741 x Fukunishiki. The gene was fine mapped to the peri-centromeric region of rice chromosome 12 and tightly linked microsatellite markers were identified.

• A new powdery mildew resistance gene (er2) was identified from an exotic pea genotype JI 2480 by screening the F2 population derived from the cross Lincoln (susceptible) x JI 2480 (resistant) with pathogen isolates virulent on another powdery mildew resistance gene er1. An F2 mapping population derived from the cross Lincoln x JI 2480 was genotyped with different markers. The analysis of data showed er2 to be situated on linkage group LG III on pea genome. One microsatellite marker and three RAPD markers were tightly linked to the er2.

• For pyramiding of powdery mildew resistance genes in pea, BC2F1 and BC3F1 of progenies of crosses Lincoln x JI 2302 (er1), Lincoln x JI 1559 (er2) and Lincoln x JI 2480 (er2) carrying powdery mildew resistance genes er1 and er2 were generated through marker assisted selection using er1 and er2 linked markers. The selfed seed from BC3F1 plants will be used to select homozygous carriers of er1 and er2.

• A study was undertaken to identify pathogens associated with wilt and root rot in Lahaul and Spiti, a major offseason pea growing region. The diseased specimens were collected from the pea fields and cultured in vitro to isolate the pathogens associated with the disease. Fusarium oxysporum and F. solani were found to be the predominant fungi associated with wilt/root rot. These fungi coexisted at all locations except Jhalma and Koksar where only F. oxysporum was detected. At locations where both the fungi were present, plants infected with both the fungi were also detected. Between the two fungi, F. oxysporum was more prevalent (associated with 61.6% wilted plants) compared to that of F. solani which was isolated from 39.6% wilted plants.

• Nine fungal isolates of seven different fungi pathogenic and non-pathogenic to peas were used for development of molecular markers for Fusarium oxysporum f. sp. pisi. The sequences of 28S rDNA, inter-transcribed spacer (ITS) and intergenic spacer (IGS) regions as well as several genes (Phosphate permease, Plasma membrane ATPase, β-Tubulin, Histone 4, Histone 3 and Pisatin demethylase) were PCR amplified using gene/region specific primers. The amplified sequences were restricted with 23 restriction enzymes to develop Fop-specific markers.

• The restriction patterns revealed that ITS, 28S rDNA and β-tubulin gene sequences were not similar. However, two PCR-RFLP markers were found to be Fop-specific. The first one was a 300 bp PCR-RFLP marker obtained after digestion of ITS regions with PstI. Another Fop-specific marker was the PCR-RFLP band obtained after restriction of 28S rDNA region with restriction enzyme MvaI. This unique product for F. oxysporum f. sp. pisi was 370 bp. Both of the markers were not detected for other fungi under test.

• Thirty one DH lines of a cross (Domo x BJ 1058) of B. juncea were generated from anther cultures
and evaluated under field conditions at Kangra. While only one DH was resistant to white rust, as many as four (Biobj 2, Biobj 29, Biobj 30 and Biobj 31) were higher yielding than the parents. In another experiment, evaluation of 19 DHs from another intraspecific cross, Varuna X Hira revealed considerable variation for seven yield and yield contributing traits. Three DHs (DH2-5, DH2-110 and DH2-111) were superior to parents for seed yield and yield contributing components.

- Molecular variability in 20 Picrorhiza kurroa genotypes was assessed through RAPD analysis. Amplification of DNA of different genotypes using 36 decamer primers (Operon series) revealed 194 bands, out of which 172 (88.65%) were polymorphic. The genotypes could be categorised into four groups named as A, B, C and D. Genetic similarity values among the genotypes ranged from 0.31 to 0.93. The robustness of the groups was confirmed by bootstrap analysis. Group A was comprised of four genotypes (M-1, M-2, M-3 and M-4) whereas the group B had three (K-1, K-2, and K-3), group C three (LS-4, LS-5 and LS-6) and group D five genotypes (C-2, C-3, C-4, C-5 and C-6). The genotypes LS-1, LS-3, LS-7, C-1, and LS-2 were not clustered into any of the groups. The genotype LS-2 from Rohtang was the most diverse genotype as did not cluster with other accessions and have only 31 per cent similarity with other genotypes.

- HPLC analysis of rhizome samples of different P. kurroa accessions from different geographical locations of Himachal Pradesh showed that Trilokinath (Lahaul Spiti) accession had the maximum content (38.80 g/kg) of Pic I followed by accessions from Barabanghal (Kangra) and Parvati Valley (Kullu). The Picroside II content was maximum (5.96 g/kg) in accessions from Barabanghal (Kangra) followed by those from Parvati Valley (Kullu) and Trilokinath (Lahaul & Spiti).

- Eight collections of Valeriana jatamansi were characterized for essential oil contents and active principles including valerenic acid and valepotriate contents. Essential oil content was highest in Tisa 1 (0.40 %), followed by Dehgran 2 (0.36 %) and Dehgran 1 (0.32 %). Valerenic acid was not detected in any of the eight ecotypes. However, valepotriate content was maximum in Kullu 1 ecotypes (3.92 %), followed by Dehgran 2 (3.30 %) and Chamba 1 (2.78 %).

**F. Agricultural Engineering**

- The cost of operation of Agria mini tiller observed was 11-16 per cent and 16-27 per cent higher in dry and wet land conditions, respectively as compared to bullock ploughing.

- The capacity of the NDUAT power tiller operated reaper was found 90 per cent more than the manual harvesting and can save 11 per cent of cost of operation and 2.5 times labour. The operation of reaper is not feasible in narrow plots having 3-4 m width.

- Optimum moisture content (15-17%) is required for less grain damage with PAU maize dehusker-cum-sheller operated with power tiller. The capacity of paddy thresher observed was 1600 kg/h which is 6 times higher as compared to traditional system i.e. 1250 kg/h.

- The power tiller operated ANGRAU wet land leveler was found suitable for leveling the puddle fields in large sized plots.

- Fertilizer dose at the rate of 150 and 125 per cent of the recommended dose of N, P and K were found to be the best for obtaining higher yield of cauliflower and capsicum in polyhouse, respectively.

- Nursery production in multi tier polyhouse was better as it did not had any adverse effect on nursery production, germination and growth and development of seedlings.

- The sequence of capsicum-cabbage-green onion and capsicum-cucumber-french bean gave the maximum production of 1328 and 1042 kg/100m²/ year in greenhouse.
G. Seed Production

- Nucleus seed of soybean (182 kg) and wheat (501 kg) was produced. A total of 29,976 kg breeder seed (11649 kg during Kharif and 18327 kg during Rabi) of different cereals, pulses, oilseeds and vegetables was produced during the period under report and offered for allocation for further multiplication by the department of Agriculture (Table 12).
- Under mega seed project on “Seed production of agricultural crops and fisheries” about 2064 kg seed and 913.5 lakh seedlings/rootlets of forage crops, 1,20,800 horticultural plants and 82,000 medicinal and aromatic plants were produced. Under organic seed production experiment vermicompost @ 2 t/ha was found to be at par with FYM @10 t/ha in wheat.

H. Tea Husbandry and Technology

- Out of the 14 tea hybrids evaluated at two locations, five tea hybrid genotypes namely, 2.18, 4.15, 8.1, 13.5 and 18.15 were found to be superior on the basis of yield contributing characters and quality parameters.
- Amongst different sources of sulphur, the application of ZnSO₄, Potash Alum and Gypsum @ 80 kg/ha exhibited comparatively higher yield to the tune of 19.4, 19.2 and 18.5 per cent, respectively. Responses of zinc-sulphur interaction studies showed that interaction of zinc @ 7.5 kg/ha and S @ 60kg/ha produced the highest yield of 64 per cent increase over control.
- The highest yield (1705 kg/ha) was obtained with a plant population of 37037/ha (90 x 30 cm) though at par with 27778 (60x60 cm) and 22222 (90x 60x 60 cm).
- The use of tea skiff compost/Albizia compost as an organic source of N nutrition in tea crops along with chemical fertilizers on 50:50 basis can save chemical fertilizers up to 50% to get the maximum yield of made tea.
- The composting and vermicomposting are found

• Enhancements to the tune of 6.5 to 11.42 per cent in biogas yield were observed in the peak winter months using cattle urine as additive. Compared to pure cattle dung based 1 m³ plant, the pure poultry litter feed plant produces 10.4-15.9 per cent total higher gas. The PAU designed slurry handling machine was modified/ refined.
• At Dhaulakuan, the highest broccoli yield of 16.06 t/ha was obtained with 10 irrigations, each irrigation of 5 cm depth (2 inches) at an interval of 14 days. The highest field water use efficiency of 321 kg/ha-cm was obtained for the treatment resulting in highest broccoli yield and it decreased subsequently with the decrease in number of irrigations.
Table 12. Breeder seed produced during the year 2006-07

<table>
<thead>
<tr>
<th>Crop</th>
<th>Variety</th>
<th>Seed Produced (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kharif 2006</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>African Tall</td>
<td>2145</td>
</tr>
<tr>
<td></td>
<td>Girija (L-118)</td>
<td>510</td>
</tr>
<tr>
<td>Soybean</td>
<td>PK 472</td>
<td>5930</td>
</tr>
<tr>
<td></td>
<td>Soya Harit</td>
<td>1287</td>
</tr>
<tr>
<td></td>
<td>Himso 1588</td>
<td>724</td>
</tr>
<tr>
<td></td>
<td>Palam Soya</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>PK 416</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>Shivalik</td>
<td>102</td>
</tr>
<tr>
<td>Paddy</td>
<td>RP-2421</td>
<td>595</td>
</tr>
<tr>
<td>Mash</td>
<td>UG 218</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>11533</td>
</tr>
<tr>
<td><strong>Vegetables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bhindi</td>
<td>P-8</td>
<td>70.18</td>
</tr>
<tr>
<td></td>
<td>Pusa Sawami</td>
<td>6</td>
</tr>
<tr>
<td>Chilli</td>
<td>Surajmukhi</td>
<td>7</td>
</tr>
<tr>
<td>French bean</td>
<td>Contender</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Luxmi</td>
<td>14.5</td>
</tr>
<tr>
<td></td>
<td>K.Wonder</td>
<td>2.3</td>
</tr>
<tr>
<td>Brinjal</td>
<td>Arka Nidhi</td>
<td>0.25</td>
</tr>
<tr>
<td>Cucumber</td>
<td>Palampur Local</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>116.13</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>11649.13</td>
</tr>
<tr>
<td><strong>Rabi 2006-07</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>HPW 42</td>
<td>4142</td>
</tr>
<tr>
<td></td>
<td>HPW 89</td>
<td>2058</td>
</tr>
<tr>
<td></td>
<td>HPW 184</td>
<td>1145</td>
</tr>
<tr>
<td></td>
<td>HPW 155</td>
<td>2148</td>
</tr>
<tr>
<td></td>
<td>HS 240</td>
<td>2517</td>
</tr>
<tr>
<td></td>
<td>HS 295</td>
<td>2257</td>
</tr>
<tr>
<td>Barley</td>
<td>Dolma</td>
<td>591</td>
</tr>
<tr>
<td></td>
<td>Sonu</td>
<td>633</td>
</tr>
<tr>
<td>Oats</td>
<td>Palampur 1</td>
<td>1189</td>
</tr>
<tr>
<td>Toria</td>
<td>Bhawani</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>DK 1</td>
<td>88</td>
</tr>
<tr>
<td>Gobhi Sarson</td>
<td>HPN-1</td>
<td>278</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>17321</td>
</tr>
<tr>
<td><strong>Vegetables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pea</td>
<td>Palam Priya</td>
<td>190</td>
</tr>
<tr>
<td>Radish</td>
<td>Japanese white</td>
<td>32.5</td>
</tr>
<tr>
<td></td>
<td>Pusa Himani</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>Palam Hriday</td>
<td>0.1</td>
</tr>
<tr>
<td>Turnip</td>
<td>PTWG</td>
<td>7.5</td>
</tr>
<tr>
<td>Chinese Cabbage</td>
<td>Palampur Green</td>
<td>163.5</td>
</tr>
<tr>
<td>Palak</td>
<td>Pusa Harit</td>
<td>80</td>
</tr>
<tr>
<td>Broccoli</td>
<td>Palam Samridhi</td>
<td>45.5</td>
</tr>
<tr>
<td>Onion (Seed)</td>
<td>Patna Red</td>
<td>10</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>Palam Upkar</td>
<td>7.8</td>
</tr>
<tr>
<td>Garlic (Clove)</td>
<td>GHC-1</td>
<td>12.5</td>
</tr>
<tr>
<td>Onion bulb</td>
<td>Patna Red</td>
<td>453</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>1006.6</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>18327.6</td>
</tr>
<tr>
<td></td>
<td><strong>Grand Total</strong></td>
<td>29976.73</td>
</tr>
</tbody>
</table>
to be most successful in tea gardens as there is high availability of recyclable bio-resources throughout the year compared to other crops. Tea skiffing litter makes the best vermicompost with high N content.

- Antracol (Propineb 70 WP), Boon (Myclobutanil WP), Wanis and Spictaf were found effective in per cent inhibition of basidiospore germination in vitro testing, whereas, Achook, Tricure, Neemgold and Neemazal remained ineffective.

- Antracol was found equally effective against blister blight as compared to Blitox. P-312 and Kangra Asha, recommended tea cultivars, were found moderately resistant against blister blight.

I. Agro-forestry and Environment

- The study on lemon grass, wild marigold and Aloe vera conducted in Model Organic Farm revealed that panchang sowing resulted in significant increase in the growth parameters over the non-panchang sowing. Significantly higher plant height, number of off-shoots and plant spread were obtained with addition of homa-bhasm.

- Essential and non-essential amino acid composition of seabuckthorn fruit pulp was studied in selected forms. Among the essential amino acids, the content of threonine, was maximum (64 mg/100g) in HI-1 form followed by Lahaul form and a minimum of 8.68 mg in Spiti form. HI-1 form also has maximum contents of valine (64.9 mg), methionine (20.5 mg), leucine (88 mg) and histidine (984.8 mg), whereas, Lahaul form has a maximum value of phenylalanine (1621 mg) and lysine (790 mg) and Spiti form has minimum values for these amino acids. Generally, the content of various essential amino acids increased with fruit maturation.

- Tea under the plantation of Albizia produced more convincing results and produced 56 per cent more made tea as compared to the control and shading of Toona produced 20 per cent more production of made tea as compared to the control.

- Based upon the availability of the raw MAP material in the study areas, under the value addition processes, 10 herbal products i.e., RTS drinks of ashwagandha, tulsi, brahmi, ginger, guava, pomegranate with sugar and stevia as sweetener and chappatis, mathri, sewian with value addition of brahmi were prepared. These products were evaluated for their quality, acceptability and further suitability for utility.

- Studies on bio-inoculants in compost enrichment revealed that compost inoculation with bio-inoculants should be used in the farmer’s field before 20 days of inoculation. Agnihotra bhasm supported the growth of bio-inoculants, so bio-inoculants can be integrated with agnihotra bhasm for the management of plant health and diseases. In BD composts, the population of Trichoderma harzinum and Aspergillus awamorii improved when applied in combination. In vermicompost, population of Trichoderma harzinum and Aspergillus awamorii was higher in rock phosphate rich composts i.e. 3.3 and 18.0cfux10^6/g respectively, whereas Azotobacter chroococcum population was 54.0 cfux10^6/g in non-amended composts.

- Addition of FYM (15.0 t/ha) in conjunction with (BD) (1.0 t/ha) compost proved to be best in increasing the growth and yield of maize gave higher yield over 20 t/ha FYM or 5 t/ha biodynamic (BD) compost.

- The combination of different composts viz. FYM (15 t/ha) and vermicompost (5t/ha) and BD compost (2 t/ha) plus vermicompost (5 t/ha) were more efficient in increasing the maize yield by 20 to 68.2 per cent as compared to alone application of these composts i.e. FYM (20 t/ha), vermicompost (15 t/ha) and BD compost (5 t/ha).

- Crops sown according to panchang showed significantly less disease severity (by 12.2 % for BSLB, 13.7 % for maydis blight, 5.6 % for turcicum blight in maize; 20.9% for target leaf spot in soybean and 11.1 % for alternaria leaf spot in Tagetes minuta) over the non panchang
Less disease severities of maize (35.6 % in BSLB, 35.1 % in maydis blight and 25.9 % in Turcicum blight) and soybean (28.7 % in target leaf spot) were observed in treatments where BD compost was applied.

Homa bhasm (disease severity 12.6 % lower over the control) or Himbio + Bt showed the disease severity 11.7% lower over the control, thus can be used for management of alternaria leaf spot in Tagetes minuta.

Himbio + Neem + Agnihotra, resulted in to minimum incidence of root rot of pea followed by himbio+ agnihotra under in vivo condition. Pea crop sown on Panchang date showed minimum incidence of root rot. Panchang sowing coupled with agnihotra ash gave best control of root rot.

Sowing according to biodynamic calendar produced significantly higher mean yield in maize, wheat as well as lentil than the non-panchang sowing.

Application of vermicompost with sowing according to panchang gave maximum grain yield (2385 kg/ha) of maize. In soybean, application of BD, vermicompost and FYM were at par in increasing the yield (1032, 955 and 926 kg/ha respectively) from 624 kg/ha in control.

Application of vermicompost being at par with BD compost significantly increased seed yield over control in wheat, while in lentil vermicompost was found to be the best treatment.

Homa bhasm was most effective in resulting maximum increasing the yield of pea.

Addition of Homa bhasm and sowing according to Panchang was found to be the best treatment in improving the yield (7.85 t/ha in first cut i.e. after 100 days after transplanting and 7.28 t/ha in the second cut i.e. 160 days after transplanting in lemon grass; and 25.2 t/ha in Tagetes minuta) and quality in term of oil content (0.41 % in lemon grass and 0.27 % in Tagetes minuta)

Lavender transplantation made with the onset of winter rains was found more suitable in terms of survival and oil recovery as compared to monsoon planting. Observations recorded on planting age of lavender (Lavandula officinalis) showed that it attains full growth for economical yield after three years of plantation.

J. Horticulture

Per cent fruit set of pecan was significantly improved by top working as well as by hanging catkins. However, increase in fruit set ovber control was 6.4-8.05 per cent by top working and 3.45-6.15 per cent by hanging of catkins in different cultivars than control.

Increasing pruning intensity resulted in better nut quality but reduced yields significantly. The treatments where height to spread ratio was kept 1:1.25 and 1:1.15, the nut quality was good and yield was also statistically at par with the maximum yield obtained in control (no pruning). ZnSO$_4$ @ 0.50% is best spray treatment for vegetative and nut characters which resulted in maximum yield i.e. 2.46 kg/tree among the four ZnSO$_4$ sprays.

Paclobutrazol treatments in pecan decreased the vegetative growth significantly with the increasing concentration. Consequently nut quality was also lowered. Though paclobutrazol @ 2.5 g/tree and 5.0 g/tree reduced the vegetative growth but the nut yield in both treatments was statistically at par with the control.

Survey was conducted in different villages of Kinnaur district of Himachal Pradesh to find out the existing natural variability in wild apricot seedling trees and to identify superior genotypes with good fruit quality characteristics. The genotypes Km-07, Bt-13 and Ku-07 were found promising as they had higher fruit size, weight, pulp recovery, total soluble solids and total sugar contents. Highest fruit length (33.52 mm), breadth (34.84 mm), thickness (33.58 mm), weight (27.31 g) and pulp content (93.51%) was recorded in Km-07 followed by Bt-13. Genotype Bt-13 had highest total soluble solids (16.23%)
and total sugars content (6.12%) followed by Ku-07 genotype, which had highest ascorbic acid content (12.29 mg/100 g fruit flesh) and reducing sugars content (3.42%).

- CPPU spray @ 5.0 ppm applied 20 days after full bloom may be used for improving fruit weight, yield and quality in kiwi fruit under Palampur conditions.

**K. Social Sciences**

- District Human Development Report of Kangra revealed that there has been a perceptible improvement in the living conditions of people in the district. The spread of development has also been discernible across all the fourteen development blocks in the district. For instance, the provisions of health, education and infrastructure facilities in the otherwise inaccessible Chhota Bhangal area of Baijnath block have eased out the harsh living conditions to a great extent. Various governmental and non-governmental organizations through SHG movement and their related rural development activities have led to the empowerment of the women folk in the district. The performance of the blocks of Baijnath, Nagrota Surian, Bhawarna, Lambagaon, Sulah, Dehra and Nagrota Bagwan with respect to health attainment was relatively better than that of the blocks of Indora, Rait, Fatehpur, Pragpur, Panchrukhi, Kangra and Nurpur. Thus, this latter set of blocks need more policy thrust on health dimension. Similarly, for educational attainment, the blocks of Dehra, Rait, Nurpur, Indora, Fatehpur, Nagrota Bagwan, Baijnath and Nagrota Surian, whose performance was below the median value among all the blocks, there was greater need to push in higher efforts towards the building up of knowledge dimension of human development.

- Study on economics of marketing management of livestock products: issues, constraints and future strategies in the hilly regions of Himachal Pradesh highlighted that various socio-economic changes occurred over a period of time along with changes of livestock rearing practices in the hilly regions. The literacy rate in case of men was higher than woman. It was observed that agriculture along with dairy was main occupation of 81.5 per cent of the households in the study area. The study also indicated that proportion of purchased inputs (feed and concentrates) increased considerably, while that the share of owned inputs decreased. The maintenance cost of a cow per year varied between Rs. 13,965 to Rs. 14,455. The labour was the next item of importance in maintenance cost. The small land size holding and low income were main problems in Zone-IV. It was also observed that animal health care was the major production problem while the marketing problem ranked second amongst other constraints. Hardly, 25 per cent of farmers’ households were engaged in the preparation of these products in Zone-I. The cost of production of ghee was worked out to be 140 per kg. Four major channels of marketing were identified. Channel-I (producer-consumer) was found to be most dominant.

- Economic survey on structure and performance of agro-processing industries in Himachal Pradesh revealed paradigm changes in structure and performance of agro-processing industries in Himachal Pradesh particularly after implementation of new industrial policy in the state. There is remarkable growth in the total capital investment and value of processed output. The processing industries are found to move towards capital-intensive methods of processing showing factor substituting of capital for human labour. This is quite evident from the differential growth and changing capital-employment ratio of these two factors. The primary processing of cereals came out to be the main component of agro-processing industries in the state. The fruit and vegetable based industries are still scanty in the state due to lack of availability of quality and cost effective raw materials coupled with marketing and infrastructure bottlenecks. It was visualized that larger processing units have better
market penetration and trade links as compared to tiny and small units.

- The studies on “Improvement of community wastelands through introduction of grass and legumes species in submontane and low hill subtropical zone of Himachal Pradesh indicated that the present productivity of the grasslands was 3.52 t/ha and it can be increased by more than four folds by third year with weeding, cleaning and fertilization of the existing grasslands. Introduction of improved grass species along with cultural practices and nutrition management can generate grassland yield up to 27.8 t/ha and it clearly highlighted potential of scientific interventions on the grassland productivity in Himachal Pradesh.

- Labour use of the various treatments over existing use was 6 to 8 time higher in the third and consecutive years. Therefore, pasture improvement can generate employment avenues for the rural people along with improvement in the environmental conditions of the area. Scope of adoption of pasture improvement and agro-forestry techniques is great because of the low investment and potentially high economic benefits.

- The investigations on diversification of hill agriculture through spice crops cultivation revealed that ginger was most important spice crop of the Himachal Pradesh but now garlic is fast catching up and has taken first position in acreage coverage. Study of market prices in Paonta market showed least price volatility in table purpose ginger prices during the months of November and December, the main production season on the crop. Garlic produce of the state hits the market in the months of May, June and price conditions during these months are generally favorable. June to October is the main production season of tomato crop in the state and its whole sale prices during this period are highly favourable. Higher productivity, comparative off-season advantage and better returns from tomato crop are major reasons for the replacement of spice crops (chillies and ginger) by this crop.

- The study was conducted in a purposively selected Hamirpur district of Himachal Pradesh to find out the training needs of vegetable growers. Results of the study revealed that a majority of the vegetable growers were old in age with low socio-economic status and belonged to upper caste, whereas an overwhelming majority of the respondents were educated. There were 61.7 per cent respondents who were marginal farmers with low total family income and 82.5 per cent farmers who put 0.20–0.33 ha area under vegetable cultivation. A majority of the vegetable growers had low extension participation whereas 45.8 per cent farmers who had low social participation and majority had moderate level of knowledge in vegetable farming. A large majority of the farmers did not receive any training in vegetable farming and 45 per cent utilised medium level of farm information sources.

- Large majority of the vegetable growers (62.5%) required high or medium level of overall training in vegetable farming. Dosage of plant protection chemicals for controlling insect-pests and diseases, flower and fruit drop and their control, plant protection measures in nursery raising, physiological disorders, time and method of controlling insect-pests and diseases, micronutrient fertilization, identification of insect-pests and diseases, awareness about varieties, dosage of weedicides, and selection of weedicides were the top ten sub-areas of vegetable cultivation in descending order in which farmers required high extent of training. The overall results of the correlation revealed that the farmers with higher socio-economic status, social participation, and good knowledge in vegetable cultivation needed less training for improved vegetable cultivation. High cost of inputs, lack of proper guidance from extension agency, poor knowledge about dosage of plant protection chemicals, uncertainty of prices, and poor availability of quality seeds
were some of the major problems perceived by the respondent in vegetable farming.

• The total cost of cultivation for cabbage was Rs. 51,164 and the gross returns turned out to be Rs. 1,20,000/ha, giving a benefit-cost ratio of 2.34. It also generated an employment of 179 mandays for the farm family.

• Only 20 per cent of the sampled farmers resorted to balanced fertilizer application on their farms and 5 per cent of them knew how to take a sample for soil-testing. Proper adoption of soil-test recommendations was limited only to 25 per cent, whereas 16.5 per cent were over-using the fertilizers. The pattern of adoption was, however, crop specific.

• In Kullu district, 80 per cent of the total marketable surplus of vegetables was marketed through regulated markets. ‘Producer-commission agent-wholesaler-retailed-consumer’ was the most common channel through which 70 per cent of the total produce was sold. Producers got 70-80 per cent of the consumers’ rupee through various channels.

II. HOME SCIENCE

Food Science and Nutrition

• Results on storage of traditional products revealed that free fatty acids, peroxide value, reducing and non-reducing sugars content of stored products gradually increased with storage intervals though the characteristics such as appearance, taste, flavour, texture, colour, doneness and overall acceptability were found to be acceptable.

• A Glycemic index study was conducted on 30 girls’ hostel residents. Low glycemic formulations prepared were found useful for GI study. The AUC for nutritious Dalia and Cheela was observed as 33.57 mg/100ml and 45.51 mg/100ml, respectively. BMI of the subjects was also calculated and it was found that the 46.6 per cent subjects had BMI less than 18.5, whereas 53.3 per cent subjects had BMI between 18.5-25 and none of the subjects had above 25.

• Nutritional evaluation of seabuckthorn and its utilization in the preparation of various food products indicated that during the first phase of the project five different methods were tried to extract juice/pulp from seabuckthorn berries, which could improve the yield/recovery of the pulp. The data further revealed that maximum recovery of juice/pulp was obtained from cold pulping (86.9%) followed by juice from soaking and grinding (71.4%), however, exactly 50 per cent of the juice recovered when the berries were individually pressed by hand and a little more when basket pressed (53.8%) or when ground with water (63.0%).

• The fresh pulp of seabuckthorn had a TSS of 120 Brix with reducing and total sugar values of 1.64 and 3.02 per cent, respectively. The acidity of fresh pulp was found to be 2.97 per cent as citric acid. The dried/dehydrated pulp and berries of seabuckthorn were rehydrated by boiling it for 30 minutes in a known amount of water. The TSS of reconstituted pulp was 8.670B and that of berries powder was 6.00B. The method used for the preparation of seabuckthorn wine is also standardized and acceptable quality wine can be prepared.

• The results of the study on nutritional quality and value-addition of under-utilized crops of Himachal Pradesh revealed that the under-utilized crops...
viz. amaranth, buckwheat, ricebean, horsegram, fingermillet and black cumin had nutritional potential that can be used for supplementation in the preparation of daily consumed recipes. The addition of amaranthus/ buckwheat/ horsegram up to 15 per cent was acceptable for making good quality chapattis whereas, the addition of buckwheat up to 20 per cent was acceptable for making cookies and pancake. The amaranth flour (up to 20%) can be used for the preparation of cake. The replacement of dosa mix up to 30 per cent with the finger millet was acceptable for making food quality dosa. The horsegram flour can be used in the preparation of nutritionally rich weaning food mixes. Amaranth ladoo of acceptable quality can be prepared in combination with coconut and jaggery.

- Food consumption behaviour and nutrient adequacy of army personnel in selected cantonment area revealed that majority of the respondents had normal BMI. Only 2 per cent were chronic energy deficient while 1 per cent was overweight. The daily energy intake, protein and fats were 86.88, 12.48 and 122.35 per cent of the RDA.

- The studies on nutritional status of selected hypertensive subjects from Palampur region of Kangra district were carried out. Sample of 150 subjects was randomly selected from the selected area. Out of the total hypertensive subjects, 54.6 per cent were male and 45.4 per cent were female. The occupation significantly affected the degree of hypertension and majority of the male subjects were of service category (57.7 %), however females were mainly housewives (50.8 %). From the information collected, 84.6 per cent of the total subjects were found to use anti-hypertensive medications and 72.7 per cent of them were taking medicines regularly. A wide range of variation was observed with respect to common meal pattern of the hypertensive subjects and majority of the male subjects were found to be non-vegetarian (52.1%). The nutrient intake by hypertensive subjects revealed that among proximate constituents, the intake of energy, protein, total fats, visible fats and fibre constituents were found to be highest by male subjects of age group of 30 –40 years.

- Value-added products were prepared by utilizing local under-utilized fruits/vegetables having promising nutritional value and consumer acceptance. Amla products were found to be shelf-stable upto 180 days of storage period under ambient conditions.

- The suitability of the under-utilized fruits viz. jamun and amla were assessed to prepare products like jam, nectar, pickle, juices, squashes, RTS, syrup, bars and pastas. The prepared products were found to be improved in respect of nutritional and microbiological parameters. The products can be kept for reasonable period under ordinary packaging at ambient storage. The products were also evaluated organoleptically for consumer’s acceptability.

- Five varieties of pea viz. Palam Priya, Lincoln, Arkal, Azad P1 and Matar Agata were selected and analyzed for their nutritional and anti-nutritional composition to see the variation due to varietal differences. The Palam Priya variety was found to be superior in all the organoleptic scores except taste in comparison to other varieties, however, in case of vitamins the Lincoln variety was found to be superior to others. Matar Agata variety was rich in micronutrients viz. iron, copper and zinc, while Azad P1 was found to be superior in macronutrients like calcium and phosphourus. The methionine and tryptophan amino acids were found to be limiting in all the varieties of peas with maximum value in Palam Piya variety.

- Storage of different chukh prepared with different treatment and sub-treatments showed losses in the nutritional value irrespective of packaging, but green chilli chukh prepared with tamarind showed good effect as compared to red and dried chillies.

- The pure jamun and kaiphal RTS was graded best and further supplementation of jamun RTS with spinach and kaiphal RTS with mango produced
acceptable quality RTS. The results of this study revealed that these fruits with immense chemical and nutritional properties can be added to the dietary system. The high content of β-carotene present in akha fruit can help in combating vitamin A deficiency diseases.

Family Resource Management

- Two new tools were developed for alleviating the drudgery of farm women involved in performing cutting and uprooting operations. The new tools designed and developed namely slashing knife and improved fauda were given to the women and were made to do the task with the tools. Thus the ergonomic assessment was done involving the physiological and muscular parameters. The results revealed that the physiological parameters such as average and peak heart rate and average and peak energy expenditure showed a significant reduction but were more than the permissible limits. The production per unit as well as the area covered under operation with the traditional tool, when compared with the improved tool showed a significant increase. The angle of deviation was much reduced with the use of improved tool thereby reducing the back pain.

- Changes have been incorporated in the Kilda with a view to make it more comfortable for carrying out the activity of tea plucking. The fodder collector has also been changed by making it lighter in weight thereby increasing the utility of the tool.

Human Development

- Under All India Coordinated Research Project on Home Science (CD component), ‘Empowerment of rural girl child’, studies on adolescent girls (n=112, age group 11-18 years) from Govt. Senior Secondary Schools in the selected five villages i.e. Bhawarna, Praur, Banuri, Rajpur and Tetahal of Bhawarna and Panchrukhi blocks of Kangra district of Himachal Pradesh revealed that there is a need to empower the girls for quality life, girls lack knowledge on vital issues like health, nutrition, ill effects of consanguinity, ideal child bearing age, menarche and hygiene during menstruation. Intervention in the areas of legal status and general awareness was provided to the girls in the schools. An increase in scores related to aspects of nutritional awareness, environmental pollution, general health problems, some aspects of child rearing practices like improving child’s behaviour were observed during the first, second and third phases of post testing.

Textile and Apparel Designing

- The conditions for printing of cotton and silk fabrics with natural dyes namely eupatorium leaves, litchi leaves, bidens whole plant, lantana leaves were standardized and optimized and tested the dyed and printed fabrics for their colour fastness to washing, crocking and sunlight.

III. BASIC SCIENCES

Microbiology

- Two microbial gene sequences were submitted to the Gene Bank of National Centre for Biotechnology Information, USA along with Departments of Entomology and Plant Pathology. The accession numbers EF 569226 and EF 600797 were allotted by the Gene Bank.

- Eighty seven isolates (69 bacterial and 18 fungal) of phosphate (P) solubilizers were isolated from the rhizosphere of Ocimum basilicum,
Pelargonium gravelones and Tagetes minuta. Out of these, 48 bacterial and 5 fungal isolates were found to be efficient P-solublizers (forming a zone of more than 5 mm) on Pikovskaya’s medium. The bacterial isolates showed phosphate solubilization activity in the range of 259 to 804 µg/ml in NBRIP (National Botanical Research Institute’s Phosphate growth medium) broth. A total of 23 isolate (22 bacterial and 1 fungal) were siderophore producers as detected qualitatively and quantitatively. Most of the siderophore producing bacterial isolates produced fluorescent colored pigment in iron free succinate medium.

- The levels of soil enzymes in long-term fertilizer experiment were determined to know the biological status of soil. Application of Zn with 100 per cent NPK had inhibitory effect on the activities of most of the enzymes studies. Hand weeding resulted in significant increase in the enzyme activities, while 100 per cent N alone had the most deleterious effect on the activity of all the enzymes.

- The periodic incidence of coliforms in some water bodies around Kangra town was monitored. A significant effect of microbiological quality of water was noticed in different seasons. Water from hand pumps located in Modern Public School, Kangra and in Gurudwara was found to be within the safe microbiological standards drinking limits.

Botany and Zoology

- 45 species of aromatic and medicinal plants obtained from Herbal gardens established at Jogindernagar (Distt. Mandi), Maranda and Gaggal (Distt. Kangra), Hamirpur, Solan were introduced in the herbal garden of CSKHPKV during the year to study their adaptability to this area so that such plants can be grown as cash crops/alternative crops in the changar area of the state. The garden is being developed to serve as a repository of the germplasm of medicinal plants of north-western Himalaya as also source of knowledge empowerment particularly of the farming community.

- Himachal bamboo has started flowering and aging and may not survive for a long time. Seminal germplasm was collected and selection of elite seedlings has been made to screen a desirable bamboo for further multiplication in Himachal Pradesh for another 30 years without any fear of flowering.

Plant Physiology

- Wheat genotypes HPW-184 and HPW-89 showed better tolerance ability under stress conditions by showing better performance in yield under all stress treatment levels having high harvest index, economic and biological yield followed by HPW-155. Genotype HS-240 was found to be drought sensitive one. The biochemical characters such as total free proline and total free amino acids were found to be more in the HPW-184 and HPW-89 followed by HPW-155 and least accumulation of these was observed in HS-240. On the basis of these observations, HPW-184 and HPW-89 were found to be tolerant, HPW-155 to be moderate and HS-240 to be sensitive to the drought.

- Screening of wheat (Triticum aestivum L.) genotypes for drought tolerance based on relative water content (RWC %) and other morpho-physiological characteristics revealed that Raj-3765 maintained higher RWC % at 60 DAS, thereby indicating that the variety showed...
impressive resilience to water stress conditions prevailed during the season.

- Wheat variety Raj-3765 showed significantly higher accumulation of above ground biomass at all the stages of sampling (38.87, 48.36 and 241.39 at 30, 60 and 90 DAS) followed by VL-829 at 90 DAS. Crop Growth Rates (CGR) were significantly higher in Raj-3765 at 0-30 DAS i.e. two leaf stage and the biomass accumulated at this state was reflected at 60-90 DAS (6.43 g/t).

- Studies on rooting behaviour of mash and Til genotypes under different moisture regimes under glasshouse conditions revealed that genotypes KU-553, KU-544 of mash and EC-334963 and LTK-4 of Til showed better root growth at 50 per cent field capacity.

**Chemistry and Biochemistry**

- The studies conducted on evaluation of pesticide levels and nutritional quality attributes of sesame (*Sesamum indicum* L) produce revealed that the overall range of variation in sesame genotypes procured from various AICRP Centres was observed from 2.26-7.32 % in moisture, 14.93-28.04 % in protein, 31.99-53.48 % in oil, 3.92-12.62 % in total sugars, 151-2711 mg/100g in lignin and 259-1808 mg/100g in oxalate content. The genotypes CST-2001 and AVT-07 were adjudged better for their oleic acid (47.56 %) and linoleic acid contents (46.18 %).

- Significant variation in biochemical constituents in horsegram (*Macrotyloma uniflorum* L. Verde) varieties/ genotypes were observed. Crude protein: 21.00 (TRS/RKS 245 ) to 26.08 per cent (HPKC-5); carbohydrates: 51.37 (HPKC-5) to 57.89 per cent (HPKC-1); crude fibre: 4.45 (HPKC-1) to 5.95 per cent (TRS/RKS-245); ash: 3.04 (HPKC-1) to 3.90 per cent (HPKC-2); methionine: 0.30 (HPKC-7) to 0.61 g/100g protein (TRS/RKS-245), tryptophane: 0.44 (IC-14350) to 0.76 g/100g protein (HPKC-4); tannins:901 (SKY/SNS-510) to 1193 mg/100 g (HPKC-5); oxalates: 201 (DMK-12) to 394mg/100 g (HPKC-43); in vitro digestibility 61.59 (HPKC-18) to 70.58 per cent (SKY/SNS-510) and cooking time:17 (HPKC-4) to 26 minutes (HPKM-149).

- Study on the polyphenolics of tea [*Camellia sinensis* (L) O. Kuntze.] of Himachal Pradesh showed that the total polyphenols and condensed tannins in green tea shoots varied significantly throughout the plucking season. Mean weekly total polyphenols and condensed tannins in the fresh green tea shoots varied in the range of 125.00-207.60g /kg (CD12.69) and 60.08-163.90 g/kg (CD10.09), respectively; whereas in made tea these varied in the range of 61.50-138.70 g/ kg (CD6.73) and 20.20-91.80 g/kg (CD4.15), respectively. Temperature, bright sunshine hours and evaporation were positively correlated with the polyphenoilc contents in green tea shoots; whereas rainfall and relative humidity were negatively correlated in tea in Himachal Pradesh. In green tea shoots, catechin and its derivatives were in the order epigallocatechin gallate > epigallocatechin >epicatechin > catechin.

- At Kangra, in gobhi sarson, oil content ranged from 35.9-41.0 per cent. Maximum oil content was observed in GSL-1 (41.0%) followed by Y-3000 (40.5%) and HNS-0502 (40.1%). Six genotypes of gobhi sarson were evaluated for oil content. Maximum oil content was observed in HNS-0301(43.0%) followed by ONK-1 (42.3%) and Kranti (42.2%).

- In Karan rai, out of eleven genotypes, maximum oil content was observed in HC-0288 (41.0%) followed by Kiran (40.4%) and Pusa Swarnim (40.3%). The oil content ranged from 38.7 - 42.5 per cent. Maximum oil content was observed in Kiran (42.5%) followed by Pusa Swarnim (40.9%) and Jayanti (40.4%).

- Saponins present in Agave americana were found to posses antifungal activity against *Alternaria brassicae* of rapeseed-mustard. The essential oil of Thuja orientalis showed antifungal activity against *Alternaria alternata* in a direct bioautography assay. Twenty two compounds representing 94.0% of the total oil were identified.
The leaf oil contained α-pinene (29.2%), Δ-3-carene (20.1%), α-cedrol (9.8%), carophyllene (7.5%), α-humulene (5.6%), limonene (5.4%), α-terpinolene (3.8%) and α-terpinyl acetate (3.5%) as major constituents.

Geo-informatics Research

- Trend analysis of the climatic parameters indicated more increase in mean surface air temperature in higher altitudinal area than lower plain area. The increase in the temperature ranged from 0.4°C to 2.4°C in different elevation zones. The rainfall in all elevations and evaporation showed significant decrease up to 2000 m amsl elevation. The water balance studies also indicated a sharp reduction in surplus water in all the elevations. Apple belt showed upward shift due to reduction of apple chill units at Bajaura and Shimla. It was evident from sharp increase in area under apple above 2000m amsl. The impact of increase in surface air temperature was also evident on crop performance viz. wheat, linseed, soybean and maize showed shortening of reproductive and maturity phases.

- Surface air temperatures both maximum and minimum temperature revealed increasing trends in all the scenarios for 2020, 2050 and 2080. The maximum temperature projections on per day basis are 0.723K to 1.39K per day for 2020 in all the scenarios. A2C scenarios projected the maximum rise of 1.3°C for 2020. The projections for 2050 and 2080 are 1.133°C to 2.123°C and 1.903°C to 3.983°C, respectively. Minimum temperature for 2020, 2050, 2080 ranges between 1.35 to 1.72, 2.54 to 3.19 and 3.74 to 5.18°C, respectively in all the scenarios. A2 scenario showed the higher range of increase. The temperature increase was 0.7 to 4.8°C in last 30 years in H.P. The precipitation projections for 2020, 2050 and 2080 showed increasing trends of annual average daily rainfall (0.12 to 19 mm) for 2020, (0.13 to 0.41mm) for 2050 and 0.28 to 0.68 mm for 2080 except A2C scenarios.

- Heavy snow fall estimated using remote sensing techniques during 2004-05 indicated an increase of 28.7 per cent (3459.0 km² area) in snow cover and ice reserve by 7.97 per cent (70.8 cubic km) compared to pre snowfall period. The mean average snow was observed to be 268.0 mm in 1984-94, 210.0 mm in 1994-2004 and 348.6 mm in 2004-05, respectively. The increase in snowfall rate from 2000m to 4000m was 74 per cent and 105 per cent higher during 2004-05 compared to last two decades. The area under different crops during Rabi, 2004 increased by 8.57, per cent but subsequent Kharif season registered 1.85 per cent reduction in cropped area. The productivity of total food grains, apple and other fruits increased by 19.0, 12.1 and 59.8 per cent during 2004-05 compared to 2003-04, respectively. The impact of heavy snow fall was more evident in short duration vegetables crops. Total vegetables arrivals in the market increased by 48.3 per cent during 2004-05 compared to last year estimates.

- The study on developing district-wise surface area of Himachal Pradesh reflected that the actual surface area of entire Himachal Pradesh, calculated using modern Geo-IT tools, remote sensing and Geographical Information System (GIS) turns out to be 86384.77 km², which is about 36 per cent more than the documented geographical area 55342.79 km². The total geographical area of Himachal Pradesh as per Govt. office records is 55,673 km². This estimation is however, two dimensional without involving the elevations i.e the undulating terrain conditions. The increase was observed to be more in the districts which lie at the height of more than 1500 m with maximum increase of > 40 per cent in the district with high hills e.g. district Kinnaur, Lahaul Spiti, Shimla, Chamba, Kullu and Kangra. In the districts with relatively flat lands e.g. Una, Hamirpur and Bilaspur the additional areas are comparatively less.

- Satluj is a major north Indian river, which is a lifeline of millions of people living downstream using its water for household consumption and irrigation purposes. This basin in the state has
been traditionally identified as a flood prone area, where every year floods cause large scale breaches in embankments subjecting over a million of population to heavy suffering and entire loss of energy, soil and agriculture. The year 2005 has seen the fury of river Satluj in devastating human lives as well as property including widespread damage to the already built/being built Hydro-power infrastructures caused either due to cloud burst or breach of lake in the upper reaches. The analysis of the flood events has been carried out as a case study and a user friendly educational module has been developed for students that would educate students with remote sensing and its application in present day information scenario in relation to earth sciences. The module will be web enabled interactive study material containing exercises and questions for students besides providing an insight into the principal causes contributing to the alarming proportions of the 2004-2005 in the state.

- Agriculture system information files for these two districts, Kangra and Mandi are prepared using Geo-informatics tools at micro level. Moreover, niches for particular crops are being identified using a geo-module “Landuse Analyst”. The study has the relevance for advancing niche based agricultural development in entire state of Himachal Pradesh. So far, an interactive mountain specific and geo-referenced database/information of agriculture in two representative districts has been developed. The output information files may be used for planning niche based agriculture development in these two districts of Himachal Pradesh.

- Customized application development can deliver/fulfill the specialized and specific needs of the users as well as it provides user-friendly environment to the users. There have been applications developed in the past but now applications developed and coupled with the advantage of GIS technologies for various data-handling, spatial analyses and visualization under variable inputs and spatial scales is an innovative approach developed during recent years.

IV. VETERINARY AND ANIMAL SCIENCES

Animal Breeding, Genetics and Biostatistics

- Identification and selection of four strata for characterization of hill cattle in each district (Kangra, Mandi and Chamba) and demarcation of breeding tract is under progress. Data have been recorded on various morphological, reproductive and production potential traits of 1500 animals in the progressive year besides conducting survey for locating the different places and farmers families having hill cattle availability. Studies indicated that hill cattle of Himachal Pradesh have six different types of coat color and among them pure black is dominant. The overall percentage of pure black, brown, black brown red, reddish brown and black with white patches were found to be 54.4, 19.6, 8.6, 3.1, 11.6, 2.6 and 51.7, 19.9, 12.0, 4.1, 9.0, 3.1 per cent in male and female, respectively. The observation recorded made it clear that black with white patches is the least found coat color (2.6 % in male and 3.1% in female) in hill cattle of Himachal Pradesh.

- The birds of the red jungle fowl were observed to be small to medium in size weighing female as 760.38 ± 107.75 and male as 1169.57 ± 74.92 g. The colour of these birds is a mixture of red, orange, black green colours. The male has bright shades of these colours whereas, females have black buff and reddish brown coloured body. The males found in this region have black feathers on the lower side where as, golden or orange red constitute the upper plumage. Males have 14 number of tail feather which are horizontally placed in both the sexes and eclipse molt with long black feather across the middle of the back and red orange on rest of the body have been observed in some of the birds. Males have bright red single comb, however, comb is missing in females.

Animal Nutrition

- Results of the study on economical utilization
of some available agro-industrial by-products in poultry feed revealed that these by-products (orange peel, orange pulp, kinnow peel and pulp, rose pomace, seabuckthorn pulp, apple pomace and marigold petal meals) can be used in poultry ration as a source of energy and protein by replacing maize and valuable ingredients being used in poultry feed. The studies further revealed that the organoleptic tests and their different nutrients remained unaltered throughout the storage period. Biological performance of broilers fed rose pomace and apple pomace as a substitute of energy and protein at 5, 10 and 15 per cent level revealed that it can be substituted at 5-10 per cent level of feeds energy and protein. The incorporation of these by-products as a substitute of protein and energy in broiler feed will certainly lower the cost of broiler production especially by lowering the feed cost thus making it a profitable entrepreneurship.

- The balanced supplementary feed has doubled the wool yield along with an improvement in its wool quality. The winter shearing gave higher wool yield in comparison to summer shearing. The economic age of Angora rabbits have been recorded as 4 years in relation to wool production.

**Veterinary Microbiology**

- Samples of lung, liver, spleen, trachea, intestine and kidney tissue were received from 2 outbreaks suspected for pasteurellosis among cattle and buffaloes in the state. *Pasteurella multocida* was isolated from one outbreak sample. Serum samples of 15 buffaloes, suspected for chlamydiosis, were received from Animal Diagnostic Laboratory, Vijaywara and one serum sample was found to be positive for Chlamydia antibody.

- *Acinetobacter lwoffii* from eye swabs of canine suffering from conjunctivitis, *Aeromonas hydrophila* from lung, liver and kidney of a leopard cub, *Moraxella phenylpyruvica* from eye of Kaleej pheasant, *Aspergillus* spp. from poultry lung and liver suspected from brooder’s pneumonia, *Candida* spp. and *E. coli*, *Proteus* spp. and *Staphylococcus* spp. were isolated from mastitic milk samples.

- Under AINP on *Haemorrhagic septicaemia*, a total of 504 samples from different animals were collected and processed bacteriologically for isolation of *Pasteurella* species. The material comprised of nasal swabs, various visceral organs and blood from apparently healthy animals as well as from suspected haemorrhagic septicaemia and pneumonic pasteurellosis cases. Out of these samples 18 were found to show positiveness for *Pasteurella* spp. the maximum samples being from Kangra district.

- Field trial of low volume saponified H.S. vaccine was conducted. The cattle calves above five months of age were vaccinated intramuscularly with 2 ml vaccine. The vaccination was carried out in different cattle breeding farms and nearby area of Palampur in 80 cattle calves. The sera samples were collected from 20 per cent of vaccinated animals at one month, three months and six months intervals. All the collected sera showed positive slide agglutination test with P. multocida P52. Sera samples were also collected from 20 per cent of vaccinated animals at 1, 3 and 6 months intervals for conducting passive mouse protection test. Results (with six month serum collection) of the study revealed that all mice survived after 48 hrs and when observed for 5
days, no further mortality was recorded, whereas in control, all mice died after 48 hours.

**Veterinary Physiology**
- A study on mineral status in blood plasma, feed/fodder, water and soil of the animals of Zone I, II and III, revealed calcium, copper and zinc deficiency, which was rectified in case of calcium and reduced to half in copper and zinc by feeding area specific mineral supplements hardly for a period of one month.
- On the basis of results of mineral level in blood of animals, feed and fodder etc. the deficient elements have been identified in different zones. At the same time, it was also observed that some elements are in excess concentration than requisite level in blood plasma as well as in feed and fodder.

**Veterinary Pharmacology and Toxicology**
- Based on the pharmacokinetic predictors of clinical efficacy i.e. Cmax/MIC ratio and AUC/MIC ratio, pefloxacin is effective at an oral dose of 8 mg/kg repeated twice daily. Similarly an intravenous dose of 20 mg/kg repeated twice daily is suggested for treatment of infections in goats.
- Interactive pharmacokinetic studies on pefloxacin with Trikatu (1:1:1 mixture of *Piper longum*, *P. nigrum* and *Zingiber officinale* at the dose rate of 2 g) in male goats revealed that both loading and maintenance dose of pefloxacin could be decreased by 6 to 15 per cent following pretreatment with *Trikatu*. A dose of 20 mg/kg intravenously or 8 mg/kg orally is suggested based on the pharmacokinetic observations.

**Veterinary Parasitology**
- A total of 74 suspected samples of different species of animals (cattle, buffalo, sheep, goat, dog, rabbit, and equine) and human were screened for the presence of parasitic infections. These samples belonged to Palampur and to the surrounding areas. Out of 74 samples, 42 were found positive for one or the other type of parasitic infection indicating overall prevalence of 56.75 per cent. In cattle, 38.23 per cent of animals were found positive. In cattle, the infection with strongyles was reported in 38.46 per cent of animals followed by amphistome (23.07%), theileria (15.38%), fasciola (7.69%) and mixed infection with theileria and anaplasma (7.69%). In sheep, the prevalence of parasitic infections was reported to be 86.66%. The highest infection reported was of strongyles (53.84%) followed by mixed infection with strongyle, trichuris and coccidia (38.46%) and lowest infection was of coccidia (15.38%) whereas 83.33 per cent of goats were found harbouring the parasitic infections. The predominant parasites observed were strongyles (60%) followed by coccidia (20%).
- Of 236 samples screened for prevalence of various gastrointestinal helminths in canines, 125 (52.90%) were found positive for one or the other type of infection. *Ancylostoma* sp. (19.06%) was the dominant species followed by *Dipylidium caninum* (16.10%), *Taenia* (8.47%), *Toxocara* sp. (5.93%) and *Trichuris* sp. (3.38%).

**Veterinary Pathology**
- Necropsy examination was conducted on 53 cattle, 14 rabbits, 138 poultry and 17 miscellaneous species. A total 222 necropsies were investigated. Some of the important disease conditions recorded during necropsy examination were tuberculosis, catarrhal enteritis, bacterial septicemia, traumatic reticulopericarditis in cattle; asphyxia, pneumonia with chronic obstruction of jejenum in sheep and goats; Colibacillosis, hydropericardium syndrome, coccidiosis, CRD, mycotoxicosis, acute pulmonary edema, rickets in poultry and encephalitozoonosis, catarhal gastroenteritis, hepatopathy leading to cardio respiratory impairment in rabbits.
- Studies on the pathology of hydropericardium syndrome in caged broilers and comparative experimental observations in broilers revealed that the chicken are highly susceptible followed by Japanese quails while ducklings and adult...
pigeons are resistant.

- Studies on mycotoxins in Japanese quail revealed that fumonisin B1 and moniliformin together can cause higher mortality. Although individually moniliformin was found to be cardiac toxic while fumonisin was hepatotoxic.

**Veterinary Clinical Medicine, Ethics and Jurisprudence**

- A total of 187 dogs were screened for the presence of anaemia. The overall incidence of anaemia was recorded as 37.97 per cent. Helminthic infection due to *Dipylidium caninum, Ancylostoma caninum* and *Toxocara canis* caused anaemia in 25.35 per cent dogs. Hepatic insufficiency occurred in 18.31 per cent cases, mineral deficiency in 14.04 per cent dogs, ectoparasitic infestation in 8.45 per cent dogs, haemoprotezoan in 2.82 per cent dogs and renal insufficiency and pregnancy in 1.41 per cent dogs each.

- Miscellaneous causes such as gastro intestinal disturbances, epilepsy, pyometra, physical trauma, stomach ulcers and tumors were associated with anaemia in 28.17 per cent of the cases. Microcytic hypochromic anaemia occurred in maximum number of cases (59.68%), followed by normocytic hypochromic (19.35%), microcytic normochromic (14.52%) and macrocytic hypochromic in 6.45 % cases of anaemia.

- Oral and parenteral iron therapy showed a marked improvement in mild to moderate anaemic dogs. Blood transfusion proved a valuable therapeutic tool in critically anaemic dogs.

**Veterinary Surgery and Radiology**

- Studies on intestinal obstruction in cross bred cattle of high altitude with special reference to prognostic, diagnostic and therapeutic aspects were conducted. The strangulated and simple cranial jejunal obstruction produced severe pathophysiology within 24 hours and 72 hours of creation respectively manifested by scant feces with mucosal/ dipherthic shreds, hypochloraemia, hypokalemia, haemoconcentration, azotemia with increased plasma alkaline phosphatase and amylase concentration. Similar signs were exhibited in strangulated and simple colonic obstruction from 3rd and 6th post obstruction day, respectively.

- In proximal intestinal obstruction the prognosis is favourable if plasma chloride is not < 75 mEq/l, plasma potassium is not < 3.5 mEq/l and hematocrit is not > 40 per cent. Whereas in distal intestinal obstruction the prognosis is good if plasma chloride is not <78.48 mEq/l, plasma potassium is not <3.73 mEq/l and hematocrit is not > 42.87 per cent. Increased ruminal fluid chloride (> 40 mEq/l) indicated outflow obstruction thus is an important prognostic factor.

- Conservative treatment following simple and strangulated jejunal obstruction in the animals of group II decreased the pace of deterioration of pathology as compared to diseased control in group I. It increased the survival time by 14 hours in strangulated and one and half day in simple intestinal obstruction as compared to control group I. Conservative treatment following simple and strangulated colonic obstruction in the animals of group II subsided pathology as compared to diseased control group I. It increased the survival time by 3.25 days in strangulated and 2.5 days in simple colonic obstruction as compared to control group I.
• Blood chloride concentration can serve as an important index for selection of fluid to be administered in both types of obstruction and should be maintained around 75mEq/l by giving ringer solution combined with potassium chloride.

• To correct the hypochloraemia, Ringer’s solution combined with potassium chloride can be given and when the blood chloride level are restored optimally, normal saline and dextrose normal saline can be given for maintenance.

• The clinical cases of intussusception in cattle presented with dehydration (PCV > 45 %), hypochloraemia (<78 mEq/l), hypokalemia (<3.5 mEq/l) and increased ruminal concentration (74 mEq/l) with severe abdominal distension, recumbency along with pregnancy had poor prognosis.

• To avoid post surgical mortality and to improve the prognosis of clinical cases of intestinal obstruction during postoperative period, the supportive treatment should comprise of Ringer’s solution, potassium chloride, isotonic saline, dextrose normal saline, calcium borogluconate, antibiotics, corticosteroids and transfaunation with rumen microflora rejuvenators (rumen cud, rice gruel with treacle) and to prevent postoperative ileus, neostigmine can be added.

• In majority of the clinical cases, intussusception of the distal intestine affecting caecocolic junction was observed and recorded primarily in the females and pregnant animals. Feeding of the Bamboo grass was found to be a major etiological factor.

• Digital per rectal examination proved an important tool for diagnosing 80 % clinical cases of intestinal obstruction and exploratory laparotomy was performed to confirm it.

• Prompt surgical intervention at intervals is needed for better post surgical prognosis of animals, like 24 hours in cranial strangulated jejunal obstruction; 3rd day in cranial simple jejunal and strangulated colonic obstruction; 6th day in simple colonic obstruction.

• Change in the colour of the peritoneal fluid from normal straw to deep yellow served as an important indicator for both proximal and distal intestinal obstruction.

• Administration of gastroprotec syrup in the dose rate of 10ml per animal twice a day orally helps in faster healing of gastric ulceration-erosions in dogs.

Animal Reproduction, Gynaecology and Obstetrics

• Metestrual bleeding was identified as a cause of repeat breeding in cows. The overall incidence of metestrual bleeding was 12.06 per cent in crossbred cows of Himachal Pradesh. Out of these 79.18 per cent were repeat breeders due to this malady. Incidence of metestrual bleeding was more in heifers as compared to pluriparous cows, however, less heifers were repeat breeders (75.93%) compared to calved animals (80.38%).

• Clinically, progesterone injected 3rd day post AI in cows with metestrual bleeding was the most efficacious. Progesterone injected 5th day post AI was equally effective. In normal cows, injecting progesterone simultaneous to insemination reduces conception rate. Exogenous administration of progesterone has no beneficial effect in improving conception in normal cows when given on day 3rd or 5th post insemination.

Veterinary Anatomy and Histology

• Study was conducted on the intestine of thirty healthy Gaddi sheep to observe the gross anatomy, histoarchitecture and histochemistry which revealed that proximal part, the small intestine had small lumen and distal part, large intestine had wider lumen. The large intestine was significantly shorter in length as compared to small intestine. Histochemical reactions were observed mainly in the striated luminal border of the columnar epithelial cells, supranuclear region of the crypt epithelium, goblet cells and Paneth cells, which showed the presence of glycogen, mucins (PAS), acidic sulfated mucosubstances (alcian blue pH 2.5), weakly acidic sulfated
mucosubstances (alcian blue pH 1.0) and lipids (Sudan Black B) in these areas.

• As for the histological and histochemical findings, the testis showed glycogen in the Leydig cells whose concentration did not vary in the different seasons. These cells also showed cholesterol with highest concentration in autumn and lowest concentration in summer. The diameter of the seminiferous tubules and the density of the Leydig cells (No. of cells/mm$^2$) was more in autumn season than in other seasons.

• The vas deferens and the epididymis were lined with pseudostratified columnar epithelium and both showed masses of sperms in their lumen. Both organs showed strong reaction for the glycogen along the apical border of their epithelium in all the seasons.

• All the accessory sex glands (ampulla of the vas deferens, seminal vesicles, pars disseminate of the prostate gland and bulbourethral gland) of both Gaddi goat and Gaddi sheep were compound tubulo-alveolar glands. All the glands showed cholesterol in their lining epithelium but no glycogen. The cholesterol reaction was maximum in autumn season and minimum in summer season.

• Only pars disseminate was present in the prostate gland of Gaddi goat and Gaddi sheep. It extended throughout the length of the pelvic urethra. At the cranial part of the pelvic urethra, the pars disseminata consisted of few secretory end-pieces (mostly serous and solid) situated on the dorsal aspect of the urethral lumen. In the middle and caudal regions of the pelvic urethra, the prostate gland consisted of both serous and mucous end-pieces; the latter increased in number in the caudal region than the middle region.

• The serous and mucous units of the pars disseminate showed PAS-reactive, diastase-resistant material in the cytoplasm (supranuclear region) of their epithelium and in their lumen; the secretion in them was also PAS-positive (diastase-resistant). This reactivity was also more in autumn and least in summer.

• The bulbourethral gland was a mixed gland being predominantly mucous in nature. The mucous end-pieces were lined with tall columnar epithelium and the serous end-pieces were lined with cuboidal (or low columnar) epithelium. Their cytoplasm also showed diastase-resistant, PAS-positive reaction similar to the mucous end-pieces. The PAS reaction in the mucous and serous units was intense in the autumn and mild in the summer.

• The pineal gland of Gaddi goat and Gaddi sheep was enclosed by a think capsule of connective tissue fibres. From the capsule, septa arose to divide the gland into lobules but the lobulation was not distinct. The parenchyma of the pineal gland consisted of pinealocytes and glial cells. The pinealocytes had large, round nuclei and their cytoplasm showed strong reaction for protein which might indicate the H1OMT enzyme present in the pineal gland.

• Four types of the glial cells could be classified in the pineal gland of Gaddi goat and Gaddi sheep based on the nuclear morphology. They were classified as Type I to Type IV cells. In the pineal gland corpora arenacea were also found which showed strong PAS reaction. From the present findings on the pineal gland of Gaddi goat and Gaddi sheep, it can be inferred that the gland is more active in summer and least active in autumn coinciding with the sexual activity of these small ruminants. As the pineal gland has antagonadotropic effect, the increased activity of the gland (in summer) has the converse (decreased) effect on the sexual activity on Gaddi goat and Gaddi sheep while the decreased activity (in autumn) of the gland has an opposite (increased) effect on the sexual activity of these animals.

Fisheries

• Based on the effect of yeast powder as one of the ingredients it is inferred that the impact of yeast powder mixed feed is more in common carp and silver carp as compared to grass carp resulting the enhancement of 16 per cent in total production.
as compared to the control when applied at low quantity. Further it is also noticed that under same environmental condition the impact of vermicompost on growth of major carp is 19.6 per cent higher than the control (cow dung).

- Genetic improvement of mirror carp and scale carp by selective breeding enhanced the growth rate, feed conversion efficiency, survivability and disease resistant strain of common carp but the prolonged winter decreased the fecundity rate of fish.

- In Mahseer feed the fishmeal can be replaced up to 57 per cent by roasted soybean and feed conversion ratio is found almost similar in both the diets. Further, it is observed that sudden decrease in temperature (from 21°C to 16°C) creates a stress environment, which is vulnerable for the fungal infection. The Mahseer cannot tolerate the temperature above 32°C when water level is less than 3 feet.

- Study of migratory routes of fish species of Beas drainage system revealed that 15 sites out of 36 selected sites are good breeding ground of Mahseer, snow trout and other endemic fish species, which needs protection. As the habitat is deteriorating due to urbanization, release of effluent, disposal of human wastes and human excreta. The extractions of riverbed materials at 14 sites were noticed, which frequently shift the substrate, thus threaten the fish species inhabited in these water bodies. Till now, 14 fish species have been reported from these sites. Silt deposition in Suketi khud at Rani Ki Bain (Sundernagar) and Dear khud at Har village and near Katha factory is a threat to breeding ground as it suffocates eggs, embryos and their food. The fishes stop to migrate from reservoir to Nakher Khud (Dehra) due to silt deposition and pollution.

- Comparative evaluation of exotic carps i.e. mirror, grass and silver carps in their composite culture with 3:2:1, 2:2:2 and 2:3:1 stocking ratios with an average initial weight of 22, 24 and 28 grams, respectively showed the gross production of 3940, 4220 and 4440 kg/ha/year. The gross production increased with an increasing number of grass carps in each combination.

- The growth of fish fauna was recorded higher in the ponds manured with rabbit excreta followed by old and fresh cow dung. The enhanced growth in case of rabbit excreta may be attributed to the availability of total nitrate-nitrogen.

Livestock Farm

- The herd strength of 247 at beginning decreased to 232 by close of the period. There were 80 live births against 95 disposals due to mortality (76 animals), auction (1 animal) and transfer (18 animals).The overall herd mortality during this year was higher (23.24%) against 16.35 per cent during 2005-06. The total milk production declined slightly to 2,38,015.5 litres with wet and herd averages of 6.72 and 5.17 lit/cow/day, respectively.

- There was significant improvement in the age at first calving (AFC), both in Jersey and crossbred heifers. The AFC lowered to 1230.71 and 1143.32 days in Jersey and crossbred heifers, respectively through better feeding and management of young heifers and growing stock and efficient reproductive management of heifers.

- The purebred Jersey cows had shown better performance for milk yield both for the first lactation yield and overall lactations yield than the Jersey x Red Sindhi crossbred cows. Further, there was substantial improvement in both these yield parameters over the previous year.

- The first as well as first three insemination conception rates were comparable in Jersey (40.0 % and 65.0 %) and crossbred (38.5 % and 61.5 %) cows. There was slight deterioration in conception rates during the year over previous year.

Livestock Products Technology

- The composition and acceptability of paneer made from different milk were studies. The standardized
milk (fat 4.5 %, 3.0 %, 1.5 % and 0.5% and SNF 8.5 %, 8.5 %, 9.0% and 8.7%, respectively) was used for the study. The data revealed that the yield of paneer was highest when prepared from milk having high fat percentage. Organoleptic evaluation also revealed that paneer prepared from milk samples having high fat percentage have highest scores for texture, appearance, flavour and overall acceptability as compared to paneer obtained from milk having less or no fat.

**Veterinary and Animal Husbandry Extension**

- Indigenous Technical Practices used by HP livestock farmers against 19 most prevailing disease conditions and husbandry practices have been identified.
- Most farmers wanted to have training on ‘basic knowledge about management of common diseases of livestock (22.1%)’. The other most ‘useful’ areas of training identified are: fodder production (21.0%); making cattle feed at home (20.0%); veterinary first aid (16.6%); and knowledge about common house-hold remedies for common diseases (13.6%).
- The most critical constraints identified were low milk yield (25.5%); lack of accessibility of artificial insemination facilities on time/need (17-16%); fodder non-availability (15.4%); disease threats (15 %) and parasite (ecto-and endo-) problems (14.7%). Mineral mixture is fed regularly by 3.8%, while commercial cattle feed is used by 48.6%. A good number of farmers (38.1 %) fed both commercial cattle feed and mineral mixture, while 11.5 % did not give either of the two to the dairy cattle.
### RESEARCH PROJECTS IN OPERATION

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Title of the project</th>
<th>Name of the Principal Investigator</th>
<th>Duration</th>
<th>Budget (Rs. in lakhs)</th>
<th>Funding agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Experiential learning setting up of facilities for hand-on training on bakery, confectionary, mushroom production, processing and packaging</td>
<td>Dean, COA</td>
<td>4/2006 to 3/2007</td>
<td>80.00</td>
<td>ICAR</td>
</tr>
<tr>
<td>2</td>
<td>Biochemical characterization of Rice bean (<em>Vigna umbellate</em>) germplasm and improvement in its nutritional quality and yield with agronomic appraisal</td>
<td>Rajan Katoch</td>
<td>4/2004 to 3/2007</td>
<td>16.64</td>
<td>ICAR</td>
</tr>
<tr>
<td>3</td>
<td>Prediction of heterosis in maize using micro satellite markers</td>
<td>Jai Dev</td>
<td>11/2005 to 10/2008</td>
<td>18.35</td>
<td>DBT</td>
</tr>
<tr>
<td>4</td>
<td>Production of quality seeds/seedlings of commercially important vegetable crops of dry temperate zone of H.P.</td>
<td>D.P. Pandey</td>
<td>8/2008 to 7/2009</td>
<td>15.48</td>
<td>ICAR (MM)</td>
</tr>
<tr>
<td>5</td>
<td>Evaluation of neem coated urea as a source of nitrogen for different crops in Himachal Pradesh</td>
<td>Naveen Dutt</td>
<td>11/2003 to 11/2006</td>
<td>2.20</td>
<td>NFL (Noida)</td>
</tr>
<tr>
<td>8</td>
<td>Improvement and transfer of oyster mushroom cultivation technology for income generation among rural women of Kangra valley in H.P.</td>
<td>Deepika Sud</td>
<td>1/2004 to 7/2007</td>
<td>9.69</td>
<td>DST</td>
</tr>
<tr>
<td>9</td>
<td>Empowerment of rural women through transfer of mushroom cultivation technology</td>
<td>Jitendra Pal</td>
<td>7/2004 to 6/2007</td>
<td>11.20</td>
<td>DBT</td>
</tr>
<tr>
<td>10</td>
<td>Collection, identification and culturing of fleshy fungi of western Himalayan region for bioactive molecules</td>
<td>B.M. Sharma</td>
<td>7/2004 to 6/2007</td>
<td>11.33</td>
<td>CSIR</td>
</tr>
<tr>
<td>12</td>
<td>Evaluation of antifungal potential of <em>Panchgavya</em> against major soil borne pathogens</td>
<td>S.K. Sugha</td>
<td>1/2006 to 12/2006</td>
<td>1.90</td>
<td>Dept. of Agri., H.P.</td>
</tr>
<tr>
<td>13</td>
<td>Refinement of management schedule of late blight of potato</td>
<td>D.K. Banyal</td>
<td>1/2006 to 12/2007</td>
<td>0.53</td>
<td>ATMA Kangra</td>
</tr>
<tr>
<td>14</td>
<td>Extraction of biologically active compounds from edible mushrooms especially <em>Pleurotus</em> spp.</td>
<td>Savita Katoch</td>
<td>7/2005 to 6/2008</td>
<td>13.32</td>
<td>DST</td>
</tr>
<tr>
<td>16</td>
<td>Eco-friendly management of PTM in Kangra valley</td>
<td>D.C. Sharma</td>
<td>2/2006 to 1/2008</td>
<td>1.80</td>
<td>Dept. of Agri., H.P.</td>
</tr>
<tr>
<td>17</td>
<td>Evaluation of servo Agro Spray T Oil against tea pests in H.P.</td>
<td>D.C. Sharma</td>
<td>5/2006 to 4/2007</td>
<td>0.86</td>
<td>Indian Oil Corporation</td>
</tr>
<tr>
<td>18</td>
<td>Promotion of vegetable production through polyhouse raised seedlings in Kinnaur</td>
<td>Pankaj Sood</td>
<td>8/2006 to 7/2009</td>
<td>18.00</td>
<td>ICAR (MM)</td>
</tr>
<tr>
<td>19</td>
<td>Planned honey bee pollination for improvement in horticultural crops</td>
<td>Y.S. Chandel</td>
<td>8/2006 to 6/2009</td>
<td>20.03</td>
<td>ICAR (MM)</td>
</tr>
<tr>
<td>20</td>
<td>Ecological and management studies in certain dry temperate and alpine pastures of Lahaul &amp; Spiti</td>
<td>B.R. Sood</td>
<td>1/2005 to 12/2007</td>
<td>5.00</td>
<td>NBDB</td>
</tr>
<tr>
<td>22</td>
<td>Integrated research and extension activities for</td>
<td>K.L. Sharma</td>
<td>12/2005 to 7/2009</td>
<td>7.00</td>
<td>Tea Board of</td>
</tr>
</tbody>
</table>
## Department of Horticulture

1. National network on integrated development of wild apricot and Cheura  
   S. Bhan  
   NOVODB

2. Supply of nucleus basic seed and planting material for horticultural crops  
   J. Badyal  
   DST

3. National network Jatropha, Karanja, wild apricot and Cheura  
   S. Bhan  
   NOVODB

4. Control of irregular bearing in Pecan  
   S.K. Upadhyay  
   ICAR

5. Trainers Training on Improved Production Technology of Horticultural Crops  
   J. Badyal  
   8/2006 to 7/2009  
   ICAR (MM)

6. Supply of nucleus basic seed and planting material of Horticultural crops  
   J. Badyal  
   8/2006 to 3/2009  
   ICAR (MM)

## Department of Vegetable Science and Floriculture

1. In vitro mutagenesis for inducing *Fusarium* wilt resistance in pea (*Pisum sativum* L.)  
   Akhilesh Sharma  
   1/2005 to 12/2007  
   ICAR

2. Standardization of polyhouse technology for off-season vegetable and nursery production in mid-hills  
   N.K. Pathania  
   8/2006 to 7/2009  
   ICAR (MM)

3. Mass scale production of quality planting material of ornamental plants in protected and open environment  
   Desh Raj  
   8/2006 to 7/2009  
   ICAR (MM)

4. Training programme on production and protection technology of off-season vegetable crops for farm women of low and mid-hills of H.P.  
   Sonia Sood  
   8/2006 to 7/2009  
   ICAR (MM)

5. Production of quality seed of garden pea and frenchbean for the benefit of vegetable growers of H.P.  
   Akhilesh Sharma  
   8/2006 to 7/2009  
   ICAR (MM)

## Department of Agricultural Economics

1. Economics of marketing management of livestock products – issues, constraints and future strategies in hilly regions of H.P.  
   S.K. Sharma  
   ICAR

2. Emerging pattern of maize production demand and processing – An impact study in hill State of H.P.  
   S.K. Chauhan  
   ICAR

3. Economic survey on structure and performance of agro-processing in H.P.  
   K.D. Sharma  
   ICAR

4. Socio-economic impact of production technology on mountain agriculture – A study of Himachal Pradesh  
   D.R. Thakur  
   1/2005 to 12/2007  
   ICAR

5. Preparation of district human development report of Kangra district  
   Virender Kumar  
   HP- Human Dev. Res. & Coordination Society

## Department of Agroforestry and Environment

1. Organic farming in hill agriculture  
   Atul  
   ICAR

2. National project on organic farming  
   K.K. Katoch  
   1/2006 to 7/2007  
   Deptt. Of Agri. & Coop.

## Advanced Centre of Hill Bioresources and Biotechnology

1. Fund for improvement of S&T Infrastructure (FIST) in universities and higher educational institutions  
   S.K. Sharma  
   DST

2. Participatory conservation and cultivation of some important medicinal and aromatic plants of H.P. involving rural women folk  
   R.K. Kapila  
   DST

3. Micro-propagation, conservation and promoting QPM of Atees and Kukti  
   T.R. Sharma  
   NMPB, GOI

4. Fine mapping of a new blast resistance specificity from a broad spectrum resistant cultivar Fukunishiki  
   Rajeev Rathour  
   DBT

5. Induction of early flowering mutant genes in horse gram (*Macrotyloma uniflorum*) and their utilization in its genetic improvement  
   S.K. Sharma  
   7/2005 to 7/2008  
   BRNS, DAE, Mumbai
6. Molecular marker assisted pyramiding of powdery mildew resistance gene and mapping QTLs for slow mildewing in *Pisum sativum*  

7. Molecular characterization of hill maize inbreds and prediction of heterosis using SSR and RAPD markers  
   Jai Dev Sharma 10/2005 to 9/2008 19.10 DBT

8. Molecular taxonomy and diagnostic for pea wilt pathogen *Fusarium oxysporum f.sp.pisi*  

9. Development of micronutrient enriched maize through molecular breeding  
   R.S. Chauhan 12/2005 to 11/2010 23.30 DBT

10. Understanding molecular genetic of bacterial wilt resistance in pepper with implications in solanaceous crops  
    R.S. Chauhan 1/2006 to 12/2008 20.43 DBT

11. Isolation and characterization of *Ascochyta rabiei* hydrophobins and elucidation of role of hydrophobins in chickpea pathogenesis  
    K.D. Sharma 5/2006 to 4/2009 18.64 DST

12. In-vivo and in-vitro mutagenesis for the Induction of early maturing determinate and blister beetle resistance mutants of *Vigna umbellate* and their exploitation for its genetic improvement  

---

**Seed Production Unit**

1. National network project on integrated development of Jatropha at CSKHPKV  

2. Seed production in agricultural crops and fisheries  
   S.C. Sharma 2005 to 2007 (2 years) 252.90 ICAR

**Centre for Geo-Informatics Research and Training**

1. Modeling environmental persistence of applied pesticides in different agro-ecological regions of Himachal Pradesh under women scientist scheme  

2. Impact adaptation and vulnerability of Indian Agriculture to climate changes  

3. Project proposal for developing district-wise surface area of Himachal Pradesh  
   R.M. Bhagat 12/2005 to 11/2006 4.77 Govt. of H.P.

4. Decision support system framework for agricultural land use planning and livelihood options for sustainable development of a mountain district of Himachal Pradesh  
   Sharda Singh 1/2006 to 12/2008 15.21 DST

5. Developing surface area 3D information files and GIS interface for planning Niche based mountain agriculture system of H.P.  
   R.M. Bhagat 2/2006 to 1/2008 5.35 Deptt. Of Agri., H.P.

   R.M. Bhagat 6/2006 to 5/2008 5.38 UGC

---

**DR. G. C. NEGI COLLEGE OF VETERINARY AND ANIMAL SCIENCES**

**Department of Animal Breeding, Genetics and Biostatistics**

1. Characterization of hill cattle  

2. Characterization and conservation of red jungle fowl under natural conditions in H.P.  

**Department of Veterinary Surgery and Radiology**

1. Studies on intestinal obstruction in crossbred cattle of high altitude with special reference to prognostic diagnosis and therapeutic aspects  
   M.S. Kanwar 9/2003 to 8/2006 7.97 ICAR

**Department of Animal Nutrition**

1. Nutritional evaluation of seabuckthorn for productive performance in cattle  

2. Economical utilization of some available agro industrial by-products in poultry feed  
   Meena Kumari 11/2005 to 10/2007 6.82 DST

**Livestock Farm**

1. National project on cattle and buffalo breeding in Himachal Pradesh: evaluation charges of NPCBB (Socio Econ. & Technology) Evaluation  
   A.S. Saini 12/2003 to 11/2006 50.00 HPLDB, AH

**Department of Fisheries**

1. Empowerment of women through aquaculture  
   Rani Dhanze 5/2004 to 9.90 DBT
### COLLEGE OF BASIC SCIENCES

1. **FIST** for COBS, Deptt. of Chemistry and Biochemistry, Microbiology and Plant Physiology
   - Dean, COBS
   - 7/2005 to 6/2008
   - 25.00
   - DST

### Department of Botany and Zoology

1. Establishment of herbal garden for teaching and research
   - Anita Singh
   - 1/2005 to 12/2008
   - 10.00
   - NMPB, GOI

### COLLEGE OF HOME SCIENCE

#### Department of Food Science and Nutrition

1. Nutritional evaluation of seabuckthorn \((Hippophae L.)\) and its utilization in preparation of various food products
   - Y.S. Dhaiwal
   - 9.17
   - ICAR

2. Home based intervention for Improvement of socio-emotional competencies in children
   - Shubhangna
   - 5.25
   - ICAR

3. Nutritional quality and value addition of under utilized crops in H.P.
   - S.R. Malhotra
   - 7.86
   - SCSTE HP

4. Farm women training in value addition of indigenous products with emphasis on post harvest management
   - S. G. Sood
   - 4.79
   - ICAR

5. Revolving fund scheme on commercial utilization of food processing plant cum community centre for the preparation of value added products
   - Y.S. Dhaiwal
   - 10/2005 to 9/2015
   - 11.40
   - ICAR

### Directorate of Extension Education

1. Dissemination of vegetable production technology amongst the farmers of Changar area of Kangra
   - D.R. Chaudhary
   - 8/2006 to 7/2009
   - 15.99
   - ICAR (MM)

### OUT STATIONS

#### Hill Agricultural Research and Extension Centre, Dhaulakuan

1. Studies on genetics of resistance against *Eruinia chrysourthemi* px. *zea* (Sabet) Victoria in maize and utilization in Development of stalk rot resistant hybrids
   - V. Kalia
   - 13.89
   - ICAR

2. Improvement of community wasteland through the introduction of improved grass and legume species in sub-montane and low hills sub-tropical zone of Himachal Pradesh
   - Purushottam
   - 4.99
   - GBPIHED Almora

3. Model organic farm
   - S.S. Paliyal
   - 4.00
   - NCOF, Gazhiabad

4. Recycling of mycelium waste as a manure by vermin-composting and its utilization in cereal and other crops
   - Kamla Kanwar
   - 8.25
   - ICAR

#### Hill Agricultural Research and Extension Centre, Bajaura

1. Evaluation of barley germplasm for biotic and abiotic stress and malting quality
   - Shiyam Verma
   - 7.10
   - ICAR

2. Identification of most economic and efficient crops/ cropping systems and their suitable niches in Kullu and Mandi districts of Himachal Pradesh
   - Brij Bala
   - 6.98
   - Deptt. Of Agri., H.P.

3. On farm integrated nutrient management for sustainable production of vegetable crops in H.P.
   - D.K. Parmar
   - 7.94
   - ICAR

#### Shivalik Agricultural Research and Extension Centre, Kangra

1. Induction of resistance against white rust \((Albugo candida)\) and Alternaria blight \((Alternaria brassicae)\) in rapeseed-mustard by natural plant products/extracts and investigation of underlying biochemical mechanism
   - Sanjay Guleria
   - 7.62
   - DST

#### Research Sub Station, Akrot

1. Development and popularization of polyhouse technology for cultivation of vegetable crops in different agroclimatic zones of Himachal Pradesh
   - Parveen Kumar
   - 6/2006 to 5/2009
   - 6.20
   - DST

#### Mountain Agricultural Research and Extension Centre, Salooni

1. Refinement, standardization and demonstration of the most suitable polyhouse technology for growing off-season vegetables
   - Vijay Singh
   - 8/2006 to 7/2009
   - 12.84
   - ICAR (MM)
### B. ALL INDIA COORDINATED RESEARCH PROJECTS

**Sr. No.** | **Research project** | **Name of the PI** | **Budget (Rs. In Lakhs)**
--- | --- | --- | ---
**COLLEGE OF AGRICULTURE**

**Department of Plant Breeding and Genetics**

1. AICRP on Under utilized Crops | Rakesh Chahota | 6.91
2. AICRP on Soybean | O.P. Sood | 8.22
3. AICRP on Forage Crops | Naveen Kumar | 31.74

**Department of Agronomy**

1. AICRP on Weed Control | N.N. Angiras | 25.20
2. AICRP on Cropping Systems Research (ECF) | H.L. Sharma | 40.03
3. AICRP on Agrometeorology | Rajendra Prasad | 6.55

**Department of Soil Science**

1. AICRP on Water Management | Pradeep K. Sharma | 35.03
2. AICRP on Long Term Fertilizer Experiments | S.P. Sharma | 13.18
3. AICRP for Investigation on Soil Test Crop Response Correlation | T.S. Vema | 21.83

**Department of Agricultural Engineering**

1. AICRP on Farm Implements and Machinery | Sukhbir Singh | 21.11
2. AICRP on Applications on Plastics in Agriculture | H.N. Vema | 21.42
3. AICRP on Renewable Sources for Agri. and Agro-based Industries (Part-I) | Anjan K. Kalia | 14.90
4. Operational Research Project Component of AICRP on Renewable Sources for Agri. and Agro-based Industries (Part-II) | Anjan K. Kalia | 10.15

**Department of Entomology**

1. AICRP on White Grubs | P.K. Mehta | 18.74
2. AICRP on Plant Parasitic Nematodes | Y.S. Chandel | 8.47

**Department of Plant Pathology**

1. AICRP on Seed Technology Research under NSP Crops (Part-II) | O.P. Sharma | 9.72

**Department of Agroforestry & Environment**

1. AICRP on Agroforestry | R. Uppal | 9.70

**Seed Production Unit**

1. AICRP on Breeder Seed Production under NSP | S.C. Sharma | 17.19
2. AICRP on Seed Technology Research under NSP Crops (Part-I) | S.C. Sharma | 12.61

**DR. G.C. NEGI COLLEGE OF VETERINARY & ANIMAL SCIENCES**

**Department of Animal Breeding, Genetics and Biostatistics**

1. Network programme on Animal Genetic Resources on Spiti Horses (Conservation unit) | P. K. Dogra | 11.00
2. All India Network project on Rampur Busher sheep | Sanjeet Katoch | 10.70

**Department Veterinary Microbiology**

1. All India Network Programme on Haemorrhagic Septicaemia | Mandeep Sharma | 5.49

**Department of Veterinary Physiology**

1. AICRP on Improvement of feed Resources and Nutrient Utilization in Raising Animal Production | K.B. Sharma | 15.50

**COLLEGE OF HOME SCIENCE**

1. AICRP on Home Science | S.R. Malhotra | 62.00

**Centre for Geo-informatics Research and Training**

1. All India Network Project on Impact on Vulnerability of Indian Agriculture to climate change | R.M. Bhagat | 11.70

**OUT STATIONS**

**Hill Agricultural Research and Extension Centre, Dhaulakuan**

1. AICRP on Wheat Improvement | S.L. Gartan | 17.96

**Hill Agricultural Research and Extension Centre, Bajaura**

1. AICRP on Maize Improvement | B.K. Shama | 32.71
2. AICRP on Barley Improvement | Shyam Verma | 17.10

**Shivalik Agricultural Research and Extension Centre, Kangra**

1. AICRP on Maize Improvement | Swaran Lata | 20.60
2. AICRP on Rapeseed-Mustard | Vedna Kumari | 18.46
3. AICRP on Linseed (at Palampur) | S. Bhateria | 31.50

**Rice and Wheat Research Centre, Malan**

1. AICRP on Rice Improvement | G.K. Sood | 31.47
2. AICRP on Wheat Improvement | S. C. Negi | 26.60

**Mountain Agricultural Research and Extension Centre, Sangla**

1. AICRP on MULLaRP | - | 28.85
IMPORTANT EVENTS

- Training on “Bioinformatics Tools in Genome Analysis” from July 5-7, 2006.
- Training on “Household Eco tourism” to members of Sangla Valley sustainable society was organized from September 21-26, 2006.
- Rice day at RWRC, Malan September 22, 2006.
- Training programme on “Organic Farming (IFOAM)” to Research staff, NGOs, Scientists, State Agriculture Officers and others from November 20-30, 2006.
- Training programme on “Organic Farming (IFOAM)” to Research staff, NGOs, Scientists, State Agriculture Officers and others from December 15-25, 2006.
- Training programme on “Organic Farming” to Research staff, NGOs, Scientists, State Agriculture Officers and others from February 11-13, 2007.
- Training programme on “Organic Farming” to Research staff, NGOs, Scientists, State Agriculture Officers and others from February 14-16, 2007.
- Training programme on “Organic Farming” to Research staff, NGOs, Scientists, State Agriculture Officers and others from February 20 to March 2, 2007.
- Training programme on “Organic Farming” to Research staff, NGOs, Scientists, State Agriculture Officers and others from May 17-19, 2007.
- Science day at RWRC, Malan on March 28, 2007.
- Fourth Annual Scientists’ Meet of All India Network Programme on Haemorrhagic Septicaemia (H.S.) from June 4-5, 2007.
VISITS ABROAD

- Dr Jai Dev, Department of Plant Breeding and Genetics attended an International course on “Biotechnology and Bioinformatics in Agricultural Plants and Microorganisms” organized by Hebrew University of Jerusalem, Faculty of Agriculture, Food and Environment Sciences, Division for External Studies, REHOVOTC (Israel) from May 9 to July 6, 2006.


- Dr C. Varshneya, Department of Pharmacology and Toxicology visited University of Torino, School of Veterinary Medicine, Grugliasco to attend 10th International Congress of the European Association of Veterinary Pharmacology and Toxicology from September 17-22, 2006.

- Dr R.K. Chahota, Department of Plant Breeding and Genetics availed the Norman Borlaug Fellowship under Indo-US Agricultural Knowledge Initiative w.e.f. September 27 to October 29, 2006 in USA.

- Dr Ranbir Singh Rana, Centre for Geoinformatics Research and Training visited Enschede, Netherlands to attend course on “Principles and Application of Remote Sensing and GIS for Natural Resource Management” organized by International Institute for Geo-information Science and Earth Observation (ITC) from October 2 to December 22, 2006.

- Dr Naveen Kumar, Department of Agronomy visited Kathmandu, Nepal to attend inception meeting of the project “Food Security through Ricebean Research in India and Nepal” at CAZS Regional Office, Kathmandu from October 3-7, 2006.

- Dr D.K. Vatsa, Department of Agricultural Engineering attended International Workshop on “R&D in Agricultural Engineering Technologies” held in conjunction with the Agricultural Engineering institute at the Ministry of Agriculture and Rural Development, Volcani Campus, Bet Dagan, Tel Aviv, Israel from October 18-31, 2006.

- Dr Sanjay Khurana, Department of Livestock Products Technology attended 7th International Post-Graduate Course on “Poultry Management: Nutritional, Physiological and Veterinary Aspects”, from November 6 to December 1, 2006 at Division of External Studies, Hebrew University of Jerusalem, Rehovot, Israel.

- Dr (Mrs.) Sapna Gautam, Department of Textiles and Apparel Designing attended training on “Advanced leadership course for Asian women in Agriculture, Research and Development” at IRRI, Philippines from November 27 to December 8, 2006.

- Dr R.K. Asrani, Department of Veterinary Pathology is on EOL from December 20, 2006 as Visiting Professor in Chonnam National University in South Korea.

• Dr (Mrs.) Jatinder Kishtwaria, Department of Family Resource Management visited Orem, Utah State valley College, USA from March 7-10, 2007 for paper presentation on “Migration in Mountain: Problems of Women”.

• Dr A.K.Kalia, Department of Agricultural Engineering attended the biogas promotion events held at Dhaka (Bangladesh) from March 26-27, 2007 as a biogas expert from India organized by Netherlands Development Organization and fully financed by Netherlands Government, Ministry of Foreign Affairs (DGIS) for the Asia Biogas Programme.

• Dr (Mrs.) Shubhangna Sharma, Department of Human Development presented a research paper entitled, “Effect of home-based intervention on socio-emotional competencies of preschool children” on “Reclaiming relational pedagogy in early childhood” at Anglia Ruskin University Combridge Chambford, U.K. from April 19-21, 2007.

• Dr Alok Sharma, Department of Veterinary and Animal Husbandry Extension visited Eritrea as Visiting Professor from March 1, 2005 to January 31, 2007.

• Dr A.K.Goel, Department of Agricultural Engineering served as Associate Professor and Head, Department of Agricultural Engineering, Hamelmalo Agricultural College, Eritrea (Africa) from March 1, 2005 to February 28, 2007.

• Dr Rajesh Chahota, Department of Veterinary Microbiology joined back in April 2007 after completing his doctoral programme from Giffu University, Japan.

• Dr Ashwani Basandrai, Hill Agricultural Research and Extension Centre, Dhaulakuan visited ICARDA, Aleppo Syria as a member of India delegation of chickpea and lentil scientists.

**PATENTS FILED**

• ‘A process for preparation of citrus based slurry used to control insect-pests in agriculture and organic farming’; patent application 766/DEL/2003 dated 02.06.2003 was accepted by the Patent Office, New Delhi.

• ‘Development of Premix blower type Biogas stove for Community Cooking’ was filed in India vide Patent application No. 1831/DEL/2006 dated 14.08.2006.

• ‘A repellant agent and a process for the preparation thereof’ has been registered vide Patent Application No 1733/ DEL/2006 dated 28. 07. 2006 and further complete application has been filed by M/S L.S. Davar & Co. on dated July 26, 2007.

• ‘A herbal dye and a process for preparation thereof’.
AWARDS AND HONOURS

• Dr. H.K. Chaudhary, Department of Plant Breeding and Genetics was awarded Himachal Kesari Award-2007 by the Hon’ble Chief Minister of Himachal Pradesh on January 12, 2007 for his outstanding contributions in Agricultural Science.

• Dr H.R. Sharma, Department of Agricultural Economics was nominated as member of the Working Group on Gender Issues, Panchayat Raj Institutions, Public-Private Partnership, Innovation Finance and Micro Finance in Agriculture in XI Five-Year Plan constituted by the Planning Commission, Government of India, New Delhi. He was nominated as member of the Sub-Group on Agricultural Indebtedness for Northern Region constituted by Expert Group on Agricultural Indebtedness, Government of India. He was also appointed Expert in Faculty of Agriculture and Forestry in Guru Nanak Dev University, Amritsar for two years. Dr H.R. Sharma was appointed member Project Review Committee, Ministry of Science and Technology, New Delhi.

• Dr Desh Raj, Department of Entomology nominated as Member, Editorial Board, Himachal Journal of Agricultural Research, CSK HPKV, Palampur.

• Dr P.C. Sharma, Department of Entomology was the editor Himachal Journal of Agricultural Research, CSK HPKV, Palampur.

• Dr. A.S. Kapoor, Department of Plant Pathology was nominated for delivering the M. S. Pavgi Lecture Award for the year 2006 by Indian Phytopathological Society, IARI, New Delhi.

• Dr. Suman Kumar and Dr. S.K. Sugha, Department of Plant Pathology won P.P. Singhal Memorial Pesticides India Award, 2006 for their research work on “Etiology, Epidemiology and Management of root rot and seedling blight of barley in Spiti valley (cold desert) of H.P.”

• Dr. V.K. Gupta, Department of Veterinary Pathology was designated as Director of Independent Study Center of Charles Louis Davis DVM Foundation of USA for the International Advancement of Education in Veterinary and Comparative Pathology.

• Dr. R.K. Asrani and Dr. V.K. Gupta, Department of Veterinary Pathology bagged a National Competitive team Research Award ‘Nemi Chand Jain and Jawahar Lal Vegad Award’ for outstanding research in Veterinary Pathology awarded by Indian Association of Veterinary Pathologists (IAVP) on their work on ‘Fumonicin B1 Toxicity and its interaction with Salmonella gallinarum and Moniliformin’ at Annual Conference of IAVP held at Chennai from December 27-28, 2006.

• Dr. C. Varshneya, Department of Pharmacology and Toxicology was nominated Vice-President of the India Society of the Veterinary Pharmacology and Toxicology.

• Dr R.K. Agnihotri, Department of Veterinary Parasitology received Best Paper award jointly with other authors in International Symposium and 5th National Conference of India Association of Veterinary Public Health Specialsits, held at Palampur from October 12-14, 2006.

• Dr S. Mittra, Department of Veterinary Parasitology received Rashtriya Gaurav award for his meritorious services, outstanding performance and remarkable role from India International Friendship Society, New
• Dr. Mandeep Sharma, Department of Veterinary Microbiology got ISVIB Mid Career Scientist award by Indian Society of Veterinary Immunology and Biotechnology.

• Dr. M.S. Kanwar, Department of Veterinary Surgery and Radiology got Certificate of Appreciation by GTZ, Palampur.

• Dr. Madhumeet Singh, Department of Animal Reproduction, Gynaecology and Obstetrics got Certificate of Appreciation by GTZ, Palampur.

• Dr. Madhumeet Singh and Dr. N.K. Vashishta, Department of Animal Reproduction, Gynaecology and Obstetrics received appreciation award by Sri Satya Sai Seva Organization on February 11, 2007 for giving commendable services in Veterinary Clinical Camps organized by the organization.

• Dr. Adarsh Kumar, Dr. S.K. Sharma, Dr. S.P. Tyagi, Dr. M.S. Kanwar and Dr. A.C. Varshney, Department of Veterinary Surgery and Radiology got special award in Radiology and Imaging session.

• Dr. S.P. Tyagi, Dr. S.K. Sharma and Dr. A.C. Varshney, Department of Veterinary Surgery and Radiology got best paper award in Ruminant Surgery during the Annual Conference of Indian Society for Veterinary Surgery at Bidar (Karnataka).

• Dr. V.K. Sharma, Department of Soil Science received Rashtriya Gaurav award for the meritorious services, outstanding performance and remarkable role in agriculture from India International Friendship Society, New Delhi during National Seminar on “Economic growth and national integration” on March 16, 2007.

• Dr S.P. Sharma and Dr S.K. Subehia received Fertilizer Association of India (FAI) Golden Jubilee Award for Excellence-2006 for the best work done in the field of “Effect of long term fertilizer use on soil health and crop productivity”.

• Dr. (Mrs.) Sapna Gautam, Department of Textiles and Apparel Designing received Young Scientist award and Best paper award during the seminar on “Serving Farmers and Saving Farming: Indian Imperative and Global Perspective” organized by Mobilization Society for Community Mobilization for Sustainable Development held on January 10-12, 2007 at GBPUA & T, Pantnagar, Uttrakhand. She also received Young Scientist award in First Uttranchal State Science Congress organized by the Uttranchal State Council for Science & Technology held on November 10-11, 2006 at DIT, Dehradun, Uttrakhand.


• Basandrai A. K., MacLeod W.J., Siddique K., Pande S. and Payne P. 2006. Evaluation of wild chickpea germplasm against Australian isolates of *Botrytis cinerea* the causal organism of* Botrytis* grey mould of chickpea. *BGM Newsletter*.


• Chaudhary A. K., Rameshwar Kumar, Vijay Rana, Punam and Atul 2006. Cultivation of Matricaria chamomilla. Journal of Tropical Medicinal Plants 7 (1) : 87-90.


• Rana M. C., Bindra A. D. and Rana S. S. 2006. Identification of suitable varieties of pea (Pisum sativum) and buckwheat (Fagopyrum tataricum) for double cropping under dry temperate conditions of north western Himalayas. *Indian Journal of Agricultural Sciences* 76(4): 222-25.


• Sharma A., Sharma R.P., and Singh Yudhvir 2006. Response of radish (Raphanus sativus L.) cultivars to different levels of fertilizers under high hill dry temperate conditions of north western Himalaya. The Indian Journal of Agricultural Sciences 76 (8):493-95.


