CHAPTER - II

AGRICULTURAL EDUCATION

The economic and social life of Haryana revolves round agriculture and its peasantry. During the British Raj, there was nothing like Department of Agriculture until 1871. The Department of Revenue, Agriculture and Commerce was then created following the recommendations of Governor General of India, Lord Mayo. Eleven years later, a Veterinary College at Lahore was established. The need for Animal Science including breeding was realized but the main focus had been on horses. Information on research and teaching with respect to animals like buffalo, goat, sheep and others was rather scanty. After realizing the importance of these animals, the emphasis on agriculture was also laid.

Major General Sir John Megaw, the Director General of Indian Medical Services submitted a report which highlighted the issues of food and nourishment. Consequently in 1907, the Government established six Agricultural Colleges at Poona (Pune), Cawnpore (Kanpur), Sabour, Nagpur, Layllpur and Coimbatore, each having the positions of Agriculturist, Economist, Botanist, Agricultural Chemist, Entomologist and Mycologist.

The Punjab of pre-independent India had two colleges of Agricultural Sciences - the College of Agriculture at Lyallpur and the College of Veterinary Medicine at Lahore. With the partition of the country in 1947, East Punjab, India- which then also included five districts of the present-day state of Haryana, had to speed up the establishment of its own similar colleges. The College of Agriculture was founded at Ludhiana and the Veterinary Medicine at Hisar. In 1956, East Punjab was integrated with PEPSU, and the Resultant State came to be known as Punjab, India. Six years later in 1962, by the Punjab Agricultural University Act, the Punjab Agricultural University with its headquarters at Ludhiana, was created. Between 1962 and the reorganization of the States of Punjab and Himachal Pradesh in 1966, three Campuses of this University had been established at Ludhiana, Hisar and Palampur. From reorganization till 2nd of February, 1970 The Punjab Agricultural University continued to serve the three new States. Later, on 2nd of February 1970, an Act of Parliament - The Haryana and Punjab Agricultural Universities Act of 1970, converted the Hisar Campus into the Haryana Agricultural University.

The University was given its present nomenclature; "Chaudhary Charan Singh Haryana Agricultural University" as a result of an amendment to the Haryana and Punjab Agricultural Universities Act (Haryana Amendment), which received the assent of the President of India on October 8, 1991. The University strives for excellence in fulfilling all three missions of a comprehensive land grant institution: the teaching, research and extension. The university which was created by an Act of Parliament in February 1970, did not have to start from the scratch and instead inherited the College of Veterinary Medicine, Agriculture and Basic Sciences & Humanities. The first two were housed in their own respective buildings and the third one occupied a part of the building of College of Agriculture. There were five hostels capable of accommodating 1121 men-students, but none for women. About 358 units of staff-housing comprising 132 for class IV employees, 88 for class III employees and only 138 for the faculty and the administrative officers of the university, had been provided. Thus, only a fraction of the faculty had campus housing. To accommodate visitors, a Teachers' home with 36 rooms had been built. Community facilities such as hospital, shopping centre, school for children and recreational facilities for employees were yet to be provided. The building to house a College of Animal Sciences was under construction, but animal sheds and poultry houses for this college had been completed and were in use. Students' population was as high as 681 undergraduates and 221 postgraduates which included 78 Ph.D. students, as well.

At present, the university follows an integrated programme of teaching, research and extension education. The teaching is carried out through its 6 constituent colleges- College of Agriculture, College of Veterinary Sciences, College of Animal Sciences, College of Basic Sciences & Humanities, College of Home Sciences and College of Agricultural Engineering &Technology located at Hisar Campus besides a College of Agriculture at Kaul. Besides, a College of Sports housed in "Giri Centre" had also existed in the intervening years. Research and extension, the other two activities, in and off the campus, are carried out at the University farms located at Hisar or at 10 Regional Research Stations, 20 Krishi Gyan and Vigyan Kendras and 6 Disease Investigation Laboratories, located in various districts of the State. This technology- transfer network spread over the entire state is controlled by a Directorate of Extension located in the campus at Hisar, which to keep the farmers alive to the fast developing agricultural science, does organize Kisan Melas and Farm Darshan every year in March and September, respectively. In addition, it does answer the farmers' immediate questions/problems on a toll free telephone line provided in "Agricultural Technology Information Centre" at Hisar campus. The University owns 6475 acres under farms, 736 acres under buildings and roads and 1453 acres land at outstations.

Keeping pace with the ever developing agricultural science, the University in the recent past has added new disciplines of Biotechnology & Molecular Biology, Centre for Food Technology & Technology, and Business Management to its existing curriculum. Thus, over the years this University has earned itself a reputation of being one of the best centres of learning in agriculture and allied disciplines.

IMPACT OF MODERN AGRICULTURAL RESEARCH

The research component of the University is coordinated by Directorate of Research. The vast spectrum of research activities are carried out under 61 state non-plan, 46 state plan, 123 ICAR (ad-hoc + AICRP), 29 NATP, 24 other agencies and one Centrally sponsored research schemes with a budgetary outlay of **Rs. 40.60 crores** (2004-2005). International collaboration in research pursuits with universities in USA, UK, Germany, Australia etc. has been fruitful. The need based and location specific research activities in the field of agriculture, animal production, animal health, basic research and home science are carried out at **9 research stations** situated in different agro climatic zones of the State. The major accomplishments are:

CROP SECTOR

Crop Improvement

- **New varieties released:** The university has released/identified 197 varieties of field crops, vegetables and horticultural crops.

VARIETY DEVELOPED AND RELEASED

Sr.No.	Crop	Level of Release		Identified/ Pipeline	Total
		Nation	State		
1.	Wheat	7	3	3	13
2.	Rice	2	3	3	8
3.	Bajra	3	5	3	11
4.	Barley	-	8	2	10
5.	Maize	4	2	-	6
6.	Pulses	12	7	5	24
7.	Oilseeds	-	16	2	18

8.	Cotton	1	12	3	16
9.	Forages	11	12	2	25
10.	Sugarcane	-	4	3	7
11.	Medicinal and Aromatic group	1	6	-	7
12.	Vegetables (22 crops)	10	30	10	50
13.	Horticulture	-	2	-	2
	Total	**47**	**111**	**39**	**197**

The varieties which have made significant contribution in increasing the production and productivity in the state are WH 147 of wheat, RH 30 of mustard, HHB 67 of bajra and HS 6 of cotton. This attempt revolutionized the agriculture in Haryana and in the neighbouring states as well. The most famous and popular varieties among the farmers are: best chapati quality variety C-306, variety WH-147 for marginal farmers, export quality variety WH-283 and recent good quality disease-resistant variety WH-711 of wheat; best malt quality variety BH-393 of barley; export quality basmati variety Taraori Basmati of rice; high protein, frost/cold tolerant variety HQPM-1 of maize; extra early maturing wonder bajra hybrid . HHB- 67 suited for inter & multiple cropping; Mung variety Muskan suitable for both *kharif* and spring seasons; resistant varieties HC-1 and HK-1 varieties of Chickpea suitable for normal, rainfed and late sowing conditions; RH-30 of Indian mustard; early maturing, medium fibre length variety H-777 & first desi cotton hybrid AAH-1 of cotton; HG-365 of Guar; single cut sorghum HC-136, sweet, tall, leafy tillering type suitable for multiple cut of sorghum SSG 59-3; CoH-99 of sugarcane and Haryana Mulathi No 1 of mulathi

CCS HAU VARIETIES SUITABLE FOR EXPORT/ INDUSTRIES

No.	***Crop***	***Variety***	***Suitability***	***Key Characters***
1.	Barley	BH 393	Malt industry, export	Malt recovery 84% Malt friability 89%
2.	Bajra	HHB 67	Value addition (diabetic products, supplementary foods)	High protein, high calcium, rich in other minerals
3.	Rice	Taraori Basmati	Export	Good aroma, length > 7 mm,

		Sugandha		non-sticky, high volume and elongation.
4.	Wheat	WH 283	Export, Baking and milling industry (bread and chapati)	Grain wt. 46.5 g/1000 (Hectolitre 75.6 kg/hl,) Bold attractive, 12.6% protein, > 74% flour recovery, resistant to Karnal bunt,
		WH 711	Baking and Milling Industry	Hectolitre wt. 78.7 kg/hl, 12.0% protein, 70.6% flour recovery, good for chapati and bread
		WH 912 (*Durum*)	Export, Industries making pasta products (Noodles, vermicelli, macroni etc.)	Golden and shinning grains with 46 g/1000 wt.,Beta Carotene 7.2 ppm, Protein 12%, Resistant of loose smut, karnal bunt
5.	Maize	HQPM-1	Baby food, food and feed industry	High protein: 3% lysine
		HM 4	Baby corn	Meets all international standards in quality
6.	Guar	HG 365 HG 563	Gum, pharmaceutical industries	Very good quality of gum, high gum content, high viscosity, preferred by textile, pharmac-eutical and related industries.
7.	Mulhati	HM-1	Ayurvedic medicines	Rated best variety at world level and has > 7% Glycyrrhzic acid
8.	Sugarcane	COH 56	Sugar industries, Highest coverage (48%) under this variety in Sonepat sugar mill zone	Early maturing, good sugar recovery
		CoH 99	Popular in Mahem sugar mill zone	Suitable for water logging and dry areas

CONTRIBUTION OF CULTIVARS DEVELOPED BY CCSHAU TO SEED PRODUCTION IN THE STATE

Sr. No	Crop	Contribution of HAU Variety		Total Seed*	% contribution**
		Popular Varieties	Quality Seed produced (q)		
1.	Paddy	HKR 126	2000	-	-
		HKR 120	500		
		HBC 19	3000		
		Total	5500	25574	21.51
2.	Cotton	H 1098	1250		
		H 56	250		
		HD 123	2000		
		H 1117	800		
		Total	5200	38847	13.39
3.	Pearl millet	HC 10	50		
		HC 20	50		
		HHB 67	2200		
		HHB 50	300		
		HHB 94	500		
		Total	3100	6899	44.93

4.	Pulses(*Kharif*)	Asha (Mung)	100		
		Muskan (Mung)	100		
		Manak (Arhar)	150		
		Paras (Arhar)	200		
		Total	550	2137	25.74
5.	Forages	Guar			
		H 365	200	653	30.63
6.	Wheat	C 306	3000		
		WH 147	12000		
		WH 283	10000		
		WH 542	10000		
		WH 711	13000		
		Total	48000	210000	22.86
7.	Gram	HC 1	2500		
		HC 3	1000		
		H.Kabuli 1	100		
		Total	3600	6100	59.02
8.	Barley	BH 75	1500		
		BH 393	500		
		Total	2000	2600	76.92

9.	Oilseeds	RH 30	1600		
		Laxmi	600		
		Total	2200	3000	73.33
10.	Lentil	Sapna	200		
		Garima	20		
		Total	220	220	100.00
11.	Maize	HHM1	450	450	100

Source : Proceedings of State Seed Production Committee Meeting

* = **Total Seed Produced in the State(q), ** % Contribution of HAU Variety in Seed Chain, *** Quality Seed Produced by various agencies(q)**

- **Elite Genetic Material registered:** University has **registered 126 elite germplasm lines** (INGR/IC no.) of various crops including vegetables and horticulture crops at NBPGR, New Delhi.

Seed Science & Technology

- The university produces approx. 1500 quintals of breeder seed of different crops/varieties every year.
- Perfected the hybrid seed production technology of sunflower and pearl-millet.
- The isolation distance for mustard has been revised from 50 to 200 m (foundation seed) and 25 to 50 m (certified seed) and it was included in Indian Minimum Seed Certification Standards.
- 18 bulletins in various areas of Seed Technology have been published.
- For low cost pelleting of pasture grasses, Seed + Clay + FYM + Sand were most effective for enhancing the field emergence and stand establishment.

- Pre-sowing seed treatment i.e. over night hydration followed by dehydration and thiram dressing @ 0.25% enhanced the laboratory germination , field emergence & yield in late sown wheat variety .
- Rapid estimation of seed viability by various biochemical tests has been standardized for cotton, cowpea and sunflower.
- Incidence of Karnal bunt of wheat and bunt and false smut of rice were higher in farmers' saved seed as compared to certified seed.
- Improved solar energy with 6-8 hours soaking in the month of September for controlling the loose smut of wheat is standardized and included in the Package of Practices.
- Treating the wheat and moongbean seed with Deltamethrin at 40 mg/kg seed not only saved the seed from insect-pest infestation in stores for six months but also did not have any adverse effect on seed viability.
- Even one pair of pulse beetle (Callosobruchus chinensis) could lead to the rejection of seed lot after one generation of insect on insect damage basis.
- The sieve sizes for various crops and varieties have been standardized and recommended to ICAR for inclusion in Indian Minimum Seed Certification Standards.
- Kasni weed seeds of berseem, Ergot infected seed in pearl-millet and pink boll worm infested seed in cotton can be separated effectively by processing.
- **An axial flow seed thresher has been designed, developed and tested in pulse and oilseed crops. The minimum seed breakage in these crops was less than 1.5%. The related documents have been submitted to NRDC for its patenting.**
- In Seed Testing Laboratory, approximately 6500 seed samples received from various sources are being tested every year.
- The department has received one NATP Project on HRD in Seed Technology from ICAR under TOE mode.
- The Centre organized trainings for scientists of ICAR Institutes & SAUs, Public and Private Sector Personnel's, Seed Growers, Farmers and Women Link Workers every year.

CROP PRODUCTION

Agricultural Meteorology

Excellent infrastructure has been created for research/extension/teaching in the discipline of Agricultural Meteorology in various specialized fields.

- University has developed agrometeorological data bank for Hisar since 1968; Climatic characterization of Hisar, Ambala, Karnal and Sirsa; Rainfall Climatology of Western and Eastern Zones of Haryana; Characterization of crop environment in Haryana viz., chickpea, pearl millet; Micrometeorological studies of pearl millet and mungbean wheat, cotton, soybean; Crop weather relationships in chickpea, wheat, mustard, mung, pearl millet, soybean; Evapotranspiration studies in wheat, summer mung, pearl millet and mustard.
- Significant achievements have been made towards crop growth modeling studies in cotton using COTTON MODEL and in Brassica juncea using BRASSICA model; Weather and pest and disease studies e.g. aphid incidence in mustard, karnal bunt infection in wheat, jassid, whitefly, heliothis, pink bollworm in cotton crops; Phenological studies using growth degree concept in pearl millet, mustard, wheat, chickpea crops under varying seeding dates were undertaken; Agroclimatological relationship between solar radiation, net radiation, albedo, sunshine duration and diffused radiation over field crops; Alternate methods of leaf area measurement using dry matter and length x breadth of leaves in sunflower were recommended; Seedling establishment studies conducted in wheat, mustard, pearl millet and chickpea.
- Simple models were developed with the use of runoff and rainfall at Hisar; Weather based agro advisory services for farmers in the region.
- Monsoon dynamics studies in the meteorological sub division; cold waves, heat waves studies in the region; dew and fog climatology of the region are being done.
- Studies on Remote sensing applications for crop growth monitoring are being conducted.

Soil Sciences

- Reconnaissance soil survey of districts Rohtak, Ambala, Hisar, Sonipat, Bhiwani, Gurgaon, Jind, Sirsa, Rewari and Kaithal. Soil survey of Jui

canal (Bhiwani) and Gurgaon canal command area was completed. **Land degradation map of Haryana state has been prepared.**

- **Soil fertility maps of N,P, K, Zn and Fe of Haryana state** have been prepared. In Haryana about 54, 21, 30, 4.4 and 2.5% soils were found deficient in Zn, Fe, S, Mn and Cu, respectively. The recommendations of soil application of 25 kg $ZnSO_4$/ha in different crops and *0.5%* foliar spray of FeSO4 for Zn and Fe deficient soil have been given.

- **Digital image processing technique of remotely sensed satellite data has been adopted *for* pre-harvest acreage and production estimation of major crops** namely viz., wheat, mustard, cotton and paddy in the Haryana state. Remote sensing (RS) estimates in general were quite comparable to those by department of Agriculture Haryana (BES) estimates.

- **Technology for the use of Saline water of EC upto 4, 8 and 16 dS/m** in barley/wheat-fallow and upto 3, 6 and 12 dS/m in mustard-fallow crop sequences, respectively on heavy, medium and light textured well drained soils in areas which received at least 400 mm rainfall annually has been developed. Pulses like chickpea, fababeen and pea can be irrigated successfully with sulphate dominated saline water of EC upto 4, 5 and 6 dS/m, respectively on medium textured well drained soils provided fields are kept fallow or rainfed farming is practiced during Kharif in areas receiving at least 400 mm rainfall annually. However their irrigation with chloride-dominated saline water of EC more than 2.5, 3.0 and 4.0 dS/m will be detrimental *for* respective crops.

- Application of FYM @ 15 t/ha alongwith 120 kg N/ha has been found to give the highest yield in different crops like pearl millet, rice, jowar and wheat. Continuous use of 15 t/ha FYM *for* three years can save all nutrients except nitrogen in pearl-millet-wheat cropping system. The recyclable crop and animal wastes produced in the state can provide about 787 thousand tons of nutrients (N, P, K, S, Zn, Mn, Fe and Cu). Application of FYM on seedlings @ 4 t/ha as mulch was very helpful in reducing the ill- effects of surface crust on seedling emergence and crop establishment in crust prone sandy loam and loamy sand. The irrigation requirement of all the important cropping system under shallow and deep water table conditions have been worked out.

- Application of suphala, SSP, DAP and UAP significantly increased the grain and straw yield of wheat over control as well as recommended

practice application. Increasing levels of P application increased significantly the yield of grain and straw of wheat. Cumulative mode of P application was best followed by direct and residual.

- **Long-term fertilization** trials with pearl-millet-wheat, jowar-wheat and guar-wheat cropping sequences under varying levels of phosphorus and potassium have revealed that (i) application of potassium fertilization had non-significant effect on yield of these crops (ii) about 80-90 per cent of the annual crop removal of potassium comes *from* the non- exchangeable pool (iii) continuous cropping steeply declined the exchangeable (754 to 268 kg K_20 ha^{-1}) and non-exchangeable K (4400 to 900 kg K20 ha-l) status of the soil (iv) after 24 years of cropping, the maximum depletion of K was observed in pearl millet-wheat followed by jowar-wheat rotations, and (v) continuous application of potassium fertilizer even at the rate of 180 kg K_2O/ha/year could not sustain the initial K status of the soil.
- The targeted yield equations *for* important crops viz., rice, wheat, mustard, pearl-millet, barley and cotton have been developed and tested in the farmer's field.
- Organic production of Basmati rice is economical and technically feasible.

Agronomy

- Developed agronomy of different crops including genotype differences. Impact of agronomic practices on water use was studied and recommendations were given on scheduling irrigation in different crops and different cropping systems.
- Various opportunities for increasing input use efficiency were explored and recommendations were given on fertilizer and various non-cash inputs. Management of drought both at experimental farm and farmers field including watershed management was done in various phases.
- Crop physiology work for establishing physiological traits, which can be used by breeders, different sources of *Brassica* (RC 781, RH 819), chickpea (H 208, C 214, H96-99) drought tolerance were identified.
- Recommendations on various cropping systems and long term impact of organic and inorganic fertilizer were generated. Agronomy of medicinal, aromatic and other under utilized plants/crops is being investigated.

- In farming system 3 crossbred cows in canal irrigated 1.0 ha holding and 30 sheeps under rainfed landless condition was found most profitable
- Vermi-compost technology was recommended.
- The herbicide resistance is *Phalaris minor* was first reported. Various recommendations on herbicides were included in the package of practices.
- The department has played a leading role in acceleration of zero-tillage and other resource conservation technologies in rice-wheat cropping system.
- Developed agronomy on crop cutting for improving the quality of fodder.
- Bed planting technique was introduced for saving of irrigation water in different crops.

Dryland Agriculture

- Developed wheel hand hoe and it was found very effective for weed management and moisture conservation.
- For dryland areas of Haryana State, application of 50 kg N + 20 kg P_2O_5/ha for pearlmillet and oilseeds and 20 kg N + 40 kg P_2O_5/ha for pulses has been found most economical.
- Advance application of fertilizer by the end of monsoon season increased mustard seed yield by 1.5 q/ha over basal application.
- **In pearlmillet and mustard crops, FYM (4t/ha) in association with Azotobacter resulted in saving of 50% of recommended dost of fertilizers.**
- Placement of 20 kg P_2O_5/ha at deeper depth was found to be equally effective to 40 kg P_2O_5/ha placed at shallow depth.
- **Harvesting of every third row of pearlmillet for fodder at 40 DAS and making ridge and furrow in this space found to be the best practice to mitigate adverse effect of drought.**
- Strip cropping of pearlmillet and mungbean in 8:4 or 6:3 ratios was more productive and economical as compared to sole crops and other intercropping systems both at research station and in ORP villages.
- Collected germplasm of mothbean, jatropha, cactus, kachchri, gartumba.

- Available soil moisture storage in one meter profile upto 175 mm, 175-225 mm and more than 225 mm were found optimum for successful cultivation of taramira, raya and chickpea crops respectively under rainfed areas.

Forestry

- The University has developed agro-forestry models with poplar as a tree component. Among different rainy season crops, turmeric was followed by cowpea grown for fodder gave maximum relative yield and net returns. Wider poplar spacing of 10 x 2.5 m and 15x 2.5 m gave higher yield of crops. During the winter season, berseem (fodder) gave higher relative yield. However, from economic point of view wheat was found most economical crop with a spacing of 10 x 2.5 m. Similarly, girth of poplar also increased with increasing spacing.

- The fertilizer studies with wheat under Poplar and Dalbergia sissoo showed that the fertilizer dose of wheat could be reduced by 25 per cent of the recommended dose.

- Cultivation of crops under Melia helped better reclamation of saline soil than cultivation of the crops and trees alone.

- Leaf samples of Prosopis cineraria , Acacia nilotica , Prosopis cineraria hybrid and Prosopis chilensis were analysed for proximate nutrients Ca , P , cell wall constituents and in vitro dry matter digestibility which revealed that it may prove to be a potential livestock fodder in periods of shortages.

- Seed orchard of Prosopis cineraria (Hybrid) and shisham were established and germplasm bank of genus Prosopis was also established for further breeding work.

- The performance of mahaneem, neem, Acacia albida and A. tortilis were found best among the tested 26 tree species at Balsamand. A technique has been developed for sand dune stabilization viz. radial/fan planting.

- Litter fall from Acacia nilotica, D.sissoo and P.cineraria improved the soil health and nutrient status of soil. Litter fall from E. tereticornis and Tamarix required comparatively more time for stabilization and decomposition.

- Sixty clones of Populus deltoides planted in field revealed that clones number 181 and 191 were found best with highest mean performance for growth parameters.
- SDS-PAGE technique revealed variation in 12 provenances of Prosopis cineraria.
- Genetic diversity in neem was estimated through RAPD markers and it revealed a wide genetic base among neem genotypes from diverse eco-geographic regions of India.
- Detailed reproductive biology of shisham, neem, khejri and mesquite has been studied.
- Seed sources of Acacia nilotica were tested for salinity tolerance. Bhopal and Dharwad seed sources were found comparatively more tolerant.
- In nurseries, soaking of cuttings of Populus deltoides in Bavistin or Dithane M-45 solution @0.3 per cent before sowing was proved to be the best against set rot/cutting rot disease. Seed treatment with Bavistin @0.3 g per kg of seed effectively enhanced seedling survival in neem and shisham. Among the biological control agents Pseudomonas maltova, P. fluroscense proved effective against pre- and post-emergence damping off in shisham.
- Large scale mortality of trees in general and shisham and kikar in particular, in diverse geographic regions can not be attributed to a single cause(s) rather a combination of factors (biotic and abiotic) might be involved. Studies are in progress to find the specific cause(s) and its management.

Entomology

- **Centre of Advanced Studies in Entomology** has been established during IX-five year plan for imparting advanced training to teachers and research workers working in State Agricultural Universities and ICAR institutes. This has been extended for the X five year plan also.
- **Biocontrol technology developed:** Sugarcane leafhopper (pyrilla), a serious pest of sugarcane has been successfully managed for the last 20 years with the use of three egg parasitoids (Tetrastichus pyrillae, Chiloneurus pyrillae and Ooencyrtus papilionis) and one nymphal-adult parasitoid, (Epiricania melanoleuca). For mass multiplying these natural enemies, a proposal was submitted to Haryana Sugar Federation and a

biological laboratory was established in 1988 at Cooperative Sugar Mill, Sonipat under the technical guidance of the University. Since then the demand of the cane-growers for bioagents is being met by this laboratory.

- Successful control of stalk borer of sugarcane through egg-parasitoid (Trichogramma chilonis) has been achieved.
- Bacillus thuringinenesis (Bt) has been recommended for the management of diamond backmoth (Plutella xyllostella) infesting cabbage.
- **Integrated pest management (IPM)** modules for the management of insect-pests of rapeseed and mustard, cotton, paddy, pulses, sugarcane and vegetables have been developed.
- **Bio-pesticides** alone or in combination with insecticides have been introduced for the management of major insect-pests of different crops viz., Cartap hydrochloride for leaf folder and stem borer in rice and neem formulations for bollworm management in cotton and for mushroom flies in white button mushroom.
- **Seed treatment** a cost effective and eco-friendly approach and easy to use with safer insecticides has been perfected for the control of termites in wheat, gram, barley, cotton and groundnut and for whitegrub in groundnut and for sucking pests in okra.
- The use of edible oils like mustard and groundnut for the control of pulse beetle have been perfected.
- **Multi-residue techniques** for the detection of pesticide residues have been developed for different food and feed commodities.
- Residues of different insecticides in vegetables could be reduced by 20-77 per cent by washing and 35-100 per cent by boiling.
- Successful summer management of Apis mellifera L. under agro-ecological conditions of Hisar has been worked out.
- **Bee keeping** maps and floral calendar of Haryana have been prepared.

Plant Pathology

- Establishment of sick plots for downy mildew of pearl millet, Ascochyta blight of chickpea root rot/wilt of chickpea and cotton for large scale screening of the material from national as well as international Institutes.

Resistant sources against these diseases have been identified and used in breeding programme for the development of resistant varieties/hybrids.

- Sources of resistant have been identified against major diseases of wheat, pulses, oilseeds, paddy, forages, cotton, vegetable crops and fruits culminating 1 into the development of disease resistant varieties suitable for growing in the state.
- Detailed investigations have been carried out on the effect of Vitavax/Bavistin in controlling seed borne infection of loose smut of wheat. Campaigns have been organized throughout the state for raising the disease free wheat crop by seed treatment with these chemicals @ 2 gm/kg seed.
- Improved solar energy treatment for wheat diseases: The seed is soaked in ordinary water (1:1 ratio W/V) in a galvanized tub (40 kg seed = 36"x36" top, 24 "x24" bottom, 13" depth) tightly covered with a transparent polythene sheet by keeping it in the sun on a calm and sunny day during the month of September. After six hours soaking the moist seed is spread out in the sun in a thin layer for the remaining part of the day/next day to dry the seed completely. The solar energy treated seed be stored in a dry place till sowing. This solar energy treatment gives the effective control of seed borne inoculum of loose smut, flag smut and karnal bunt diseases. For the treatment to be effective, there should be no leakage in the tub or cut in the polythene sheet.
- Since chemical control of soil borne diseases is economically not viable and environmentally unsafe, biological control by using *Trichoderma viride* has been promoted. This treatment also fits suitably in the integrated disease management programme.
- Techniques have been standardized for the cultivation of white button, oyster and white milky mushroom for growing in low-cost mushroom houses in the villages as well as in modernize mushroom houses. Low-cost mushroom production technology by using cotton sticks, wheat straw, paddy straw and *brassica* straw has been developed. Facilities have been developed for the supply of spawn and pasteurized compost to the growers. Specialized trainings are being conducted by the scientist on the cultivation of different types of mushroom in each district as well as on the main campus. Haryana has become a leading state in the mushroom cultivation in the country.

- Spray schedules have been standardized for the control of major diseases of crop plants, vegetables and fruits after thorough experimentation as per the need of the state. Further studies are in progress on the management of diseases through plant extracts and resistance inducing chemicals.
- Epidemiology of major fungal, bacterial and viral diseases has been studied. Disease forecasting modules have been developed for some of the economically important diseases prevalent in the state.
- The influence of V A mycorrhizal inoculation on the growth and development of plants in rock-phosphate amended soils has been studied. Phosphate uptake is greater in deficient than in P-rich soils. Further mycorrhiza fungicide interaction have also been studied. The ability for increased P-uptake by mycorrhizal roots was very much reduced when soil was treated with thiram or brassicol. The role of mycorrhizal model system in suppression of soil borne pathogens has been studied extensively. Inoculation with mycorrhiza results in extensive colonization of roots and reduction in the percentage of plants infected with the pathogens.
- Since existence of pathogenic variability poses a serious problem in developing a resistant variety for a particular geographic area, this phenomenon has been studied extensively among major plant pathogens of sugarcane, pulses, oilseeds and vegetable crops. These studied have helped in breeding the varieties suitable for cultivation in the state.
- Diagnostic techniques have been standardized for the identification of viral diseases of potato, tomato, chilli, cucurbits, sugarcane, cowpea and cotton. Further molecular studies have been conducted on cotton leaf curl virus for variability as well as incorporation of resistant genes.

Nematology

For management of key nematode pests of the state following eco-friendly and economically viable techniques have been advocated and included in the package of practices.

- To harness solar energy 2-3 deep summer ploughings during the months of May and June at an interval of 10-15 days has been recommended.
- Growing of mustard as a non host crop for management of 'Molya' disease of wheat caused by Heterodera avenae.

- Use of HT-54 strain of Azotobacter chroococcum as seed treatment in wheat against Heterodera avenae.
- For eradication of seed borne earcockle and 'tundu' diseases of wheat, use of certified seed/water floatation technique has been recommended.
- Cultivation of Hisar Lalit variety of tomato (developed by HAU) and c-164 variety of barley has been recommended in root knot and molya affected fields respectively.
- Judicious use of carbofuran as nursery bed treatment in rice and vegetables, and as spot treatment in fruit crops has been recommended against key nematode pests.
- Use of rhizospheric bacteria, Gluconacetobacter diazotrophicushas been included in the Package of Practices for the management of root-knot nematode infecting cotton.

Horticulture

- Rich collection of germplasm of major crops like ber, aonla, grapes, guava, citrus, peach and mango has been made and evaluated to recommend superior cultivars for commercial cultivation in state. In grapes, cultivars recommended are Beauty Seedless, Perlette, Delight and Thompson Seedless; in Citrus, Kinnow in Sangtra. March seedless,, Duncan and Foster Pink in grapefruit; Kagzi kalan and Baramasi in lemon; jaffa, Pineapple, Mosambi, Blood Red in Sweet orange; in guava L-49, Allahabad Safeda, Banarasi Surkha hybrids Hisar Safeda and Hisar Surkha; in mango, Chausa Dashehari, Amarpali, Malika, Fajri, Sipia Shah Pasand, in Aonla NA7, NA10, Banarasi, Chakaiya.
- Collection and evaluation of varieties of fruits viz. mango, sapota, litchi, pearl, peach, plum, loquat was made at RRS, Buria.
- Two guava hybrids namely Hisar Safeda (Allahabad Safeda x Seedless) and Hisar Surkha (Apple Colour x Banarasi Surkha) have been released for commercial cultivation. They have less and soft seeds and more pulp and sweetness.
- Safeda Rohtak, BS 75-1 and BS 75-3 ber germplasm resistant against powdery mildew alongwith two guava genotypes were registered in NBPGR.

- Germplasm of flowers like rose, gladiolus, chrysandthemum and marigold has been made and superior varieties have been recommended for cultivation.
- In rootstock trial of sweet orange fruit, two rootstocks viz. Cleopatra and Troyer showed better performance with respect to yield and quality in comparison to existing rough lemon. There was better compatibility with the scion cultivars and less decline.
- For crop regulation in guava, with holding of irrigation from Feb. to May and spray of 300 ppm NAA at the time of flowering reduced the rainy season crop and increased the winter crop.
- The pruning and spacing was standardized in ber, grapes, phalsa.
- The nutritional requirements of various fruit and flower crops have been standardized.
- Leaf sampling technique for diagnosing the deficiencies of nutrients has been standardized in mango, ber, grapes, guava; citrus.
- Nutritional survey of ber orchards in Haryana revealed the deficiency of organic carbon in 75 per cent orchards. Nitrogen content of leaves was low in 40 per cent orchards whereas P & K in 60 per cent orchards in north-western part of Haryana. Nutritional survey of pear orchards in state was carried out.
- Micro-propagation of rose strawberry, chrysanthemum lilium, carnation, guava and grapes has been standardized.
- For control of fruit drop in mango 2% sprays of urea and 20 ppm NAA in April, May were found most effective. Spray of 10 ppm 2,4-D sodium salt+20 ppm aureofungin + 0.5% zinc sulphate in June, July and September was able to check fruit drop in citrus.
- Modified atmosphere packages were standardized for, citrus, guava etc. Kinnow can be stored upto 56 days, lemon 56 days and guava 8 days at room temperature.
- Use of zero energy chamber was helpful for short-term storage of fruits and vegetable specially in the summer months.
- Method for preparation of various products viz. RTS drink, Juice, vinegar, wine, preserves etc. has been standardized in various fruit crops.

Vegetable Sciences:

- Forty varieties of vegetable and spice crops have been developed and released.
- Disease/insect-pest resistant/tolerant varieties (12) fenugreek (3), round gourd (1), Brinjal (2) Okra (2), tomato (2) and chilli (2) have been developed and released.
- High temperature tolerant brinjal(2) and salinity tolerant onion (2) varieties released.
- Nineteen other varieties of vegetable and spice crops are in advance stage for release.
- Seven hybrids viz. HBH-142 of okra, HTH-2-2 of tomato, HBGH-20 and HBGH-35 of bottle gourd and HKK-56, HKH-58 and HKH-96 of bitter gourd found promising for farmers field testing.
- Tomato breeding lines H78-3 and HT-3-1 found highly resistant to TLcV and early blight.
- Hybrid seed production technique in tomato using genetic marker and PGR (GA) developed.
- Ten promising lines of vegetable and spice crops registered with NBPGR, New Delhi.
- Production technologies of most vegetable and spice crops have been standardized.
- Non-conventional vegetables-asparagus, Chinese cabbage, red cabbage, lettuce, celery, leek, parsley, Brussels sprouts, kale and broccoli have been found successful for cultivation in Haryana.
- Cropping systems-paddy-potato-wheat, potato-tomato-sorghum and potato-bottle gourd-green manure have been found remunerative in Haryana.
- Bio-control of Rhizoctonia solani in potato with Trichoderma spp. has found effective when tubers treated before sowing.
- Biofertilizers Azospirillium in onion, Azotobactor (Msx-9) in potato, fennel & coriander saved 25% N.
- Inter-cropping of fennel and coriander with potato, tomato and cauliflower found remunerative.

- Weed control with pendimethalin @ 1.0 to 1.250 kg/ha found effective in most of the vegetables.
- Irrigation requirement and scheduling for most of the vegetable and spice crops standardized.
- Plant growth substances improved yield upto 25-40% in some vegetable and spice crops.
- Protected cultivation of cucurbits and solanaceous fruit vegetables and their seedlings can successfully be raised under polyhouse and green house.
- To meet the requirement of various seed producing agencies, university produces seed of different vegetable and spice crops to the tune of Rs. 5-8 lacs as per requirement.

AGRICULTURAL ENGINEERING SECTOR

Farm Power and Machinery

- Tractor drawn automatic lister cutter sugarcane planter was tested and demonstrated at the farmers field in the districts of Hisar, Kurukshetra. It was capable of planting 30-32 setts in a row of 10 meter length with a row to row distance of 75 cm. The field capacity of the machine was 0.22 ha/hr and germination count of 5-6 plants per meter square.
- No till planting of wheat crop after paddy was successfully demonstrated at farmers' fields. The results of the trials have revealed that an increase ranging between 5-.1 0 per cent in grain wheat in no tillage system of planting of wheat as compared to conventional tillage system. However it is a situation specific technology and suits well in the areas where soil could not be prepared due to its aberrant soil structure and continued excessive moisture.
- Tractor drawn bed planter has been successfully demonstrated for chickpea (gram). The demonstrations were given under Front Line Demonstration (FLD) program. The results of the trials have revealed that the crop yield can be increased up to 20 per cent by the use of the machine. The technique can save 35-40 per cent water.
- Paddy transplanter using mat type nursery was successfully demonstrated at farmers' field. Trials were organized for manual as well as power operated transplanter. The results have revealed that raising mat type

nursery on the perforated plastic base with perforations provided at 5x5 cm spacing was quite successful. The use of machine on an average increased the crop yield by 7.6 per cent. However growing of mat type nursery at the farmer's field was quite difficult and cumbersome as reported by the farmers.

- Straw combine for harvesting wheat straw left after combine harvesting was successfully demonstrated, The technology has been adopted by the farmers. The machine has given a straw recovery of 70-80 per cent with straw split of 92 per cent and field capacity of 0.5 - 0.6 ha/hr, Additionally 100-150 kg of grain per hectare are also recovered which almost equaled to the amount of custom hiring charges.
- Tractor drawn ridger seeder cum seed fertilizer drill has been developed and large no. of demonstrations have been organized at farmer's field. The machine accomplishes seeding of crops in paired rows (30:60 cm) ridge furrow system with provision of inter row rain water harvesting and improves the crop stand and consequently the yields of crops. The machine can also be used as seed fertilizer drill for the sowing of various crops. Demonstrations have been carried out for all seed and chick pea crops. The results have revealed that the crop yields are increased 15-20 per cent by the use of machine which can sow 4-5 ha/day. There is 35 -40 per cent saving in irrigation water.
- A tractor drawn walk behind power weeder was evaluated at farmer's field for interculture operations in sugarcane crop. The field capacity of the machine was observed to be 0.102 ha/hr at the speed of 1.6 kin/hr. The weeding efficiency of the power weeder was 60.4 per cent and 63.2 per cent after the first and second pass of the weeder and the plant damage was 1.6 per cent. The field efficiency of the machine was 96.0 per cent and the fuel consumption was 0.3 l/hr and 2.9 l/ha. The labour requirements by this machine was 10 man -hrs/ha as compared to 150-160 man-hrs/ha by the traditional methods. The cost of weeding by power weeder was Rs. 1293 per ha as compared to Rs. 2048 per ha by manual hoeing.
- Tractor drawn rotavator was evaluated and adoptive research trials carried out at farmer's field for its popularization. It was observed that the average depth of puddling was 13.93 cm in comparison to 15.7 in local practice. Puddling index of the rotavator prepared fields was 60.87 per cent as compare to 48.5 per cent achieved in local practice which is a good indicator of saving of irrigation water required by the crop during

the growth period. One dry harrowing operation under upland condition followed by the one operation of rotavator in flooded condition resulted in field capacity of 0.254 ha/hr compared to 0.17 ha/hr for local practice of one operation of dry harrowing followed by two harrowing in flooded condition. There was 33.18 per cent saving in time and 14.78 per cent in cost of operation with the use of rotavator combination over the traditional practice.

Soil & Water Engineering

- Sub-surface horizontal drainage technology for reclamation of waterlogged and saline lands has been developed.
- A vertical drainage technology for skimming good quality water overlying relatively poor quality was also developed.
- Drip irrigation technology for wide spaced horticultural crops and vegetable crops grown in light sandy soils has been developed. High frequency drip irrigation has also been tested to make effective use of drainage effluents.
- The design specifications for surface method of irrigation viz. Border, Furrows and Checks for various soil types and flow rates have been finalized.
- Regional water balance model to study different water balance components, their interaction and effect on groundwater levels has been developed. A new methodology has been developed to determine effective soil hydraulic parameters for regional studies by making integral use of simulation models, remote sensing information and parameter optimization techniques.
- Alternate irrigation schedule has been developed and tested using field experiments and computer simulation models for the conjunctive use of good quality canal water and saline ground water.
- It was established by modeling that Bio drainage is feasible in Balsamand sub branch and Rana distributory command areas.

Processing and Energy

- Delinting of cotton seed with diluted sulphuric acid is under commercial use.
- Development of solar Hara for simmering of milk and cooking of animal feed

- Development of wheat straw fortification machine
- Development of Aonla pricking machine-patent application field.
- Solar drying of fruits and vegetables
- Optimized operational parameters of bucket elevators
- Drying of different crops
- Stabilization of rice bran using microwave energy

ANIMAL HUSBANDRY SECTOR

Animal Health

- **Excellent modern veterinary clinics facilities** provides round the clock animal health service to the farmers. This facility is being utilized effectively not only by the farmers of the Haryana state but also of adjoining states like Punjab, Rajasthan and Delhi.
- **Network of Disease Investigation Centres at district headquarters** of the State has been established. These Laboratories are engaged in diagnosis of diseases of livestock and poultry and suggesting preventive and control measures.
- **Disease free small animal house**, a unique facility not available in other agricultural universities is raising small animals viz. rabbits, mice, guinea- pigs, hamsters etc. are raised under controlled environmental conditions. These animals are extensively used for research within the university and also supplied to more than 40 outside agencies.
- **Specific and sensitive diagnostic tests** viz. indirect fluorescent antibody test and ELISA were developed for diagnosis of haemoprotozoan diseases these infections. A rationale of therapy for these diseases has been found successful. A protective cell culture vaccine for the control of bovine tropical theileriosis has been developed. This vaccine is safe and effective for all breeds and age group of cattle.
- Thiamine hydrochloride was found to be an effective drug in treatment of polioencephlomalacia of sheep.
- **Therapeutic efficacy of indigenous drug** 'Hathiboora' was tested in the clinical cases of rheumatism-like syndrome in buffaloes. The study showed that the indigenous drug 'Hathiboora' was required to be given

for a longer period than others for clinical recovery. The treatment with a combination of sodium acid phosphate and mineral mixture was found to be the best.

- **Technology for effective treatment of production diseases** and deficiency diseases such as milk fever, haemoglobinurea, kitosis, rheumatic syndrome pica etc. were developed which helps in saving life as well as sustained productivity of precious animals.
- The indirect antigen ELISA could be used effectively for evaluation of chemotherapy and epidemiological studies in livestock for *Trypanosoma evansi* infection. Levamisole hydrochloride (@ 7.5 mg/kg b.wt. orally) is very effective in elimination of immature stages of Toxocara *vitulorum* in 11 day old buffalo calves.
- On the basis of specificity, sensitivity and predictive value of positive tests. CMT and bromothumol blue tests were found to be better animal side tests for screening of large herds, whereas NAG-ase test could be used as preference laboratory test in comparison to SCC to detect sub-clinical mastitis. Staphylococci were the predominant organism examined culturally. The maximum cases of mastitis were of sub-acute type in cows and chronic type in buffaloes. The maximum number of cases was reported during first four lactations and mainly during first five month of lactation. **A combination of intramammary infusion with intra muscular injection of antibiotic resulted in a greater percentage of bacteriological cure than intra-mammary infusion and intra muscular injection alone.**
- **MTT dye reduction assay was proved for having highest sensitivity for detection of subclinical mastitis.** Treatment by teat canal therapy was efficient and cost effective than udder therapy during dry period for treatment of mastitis.
- **Post-parturient haemoglobinuria (PPH)** is a metabolic disease occurring commonly in buffaloes in Haryana and rarely in crossbred cows in other parts of Indla. It has not been reported in indigenous cows. It was found that lower lipid peroxidation (Oxidative stress), the higher antioxidant status and normal phosphorus levels in apparently healthy indigenous cows could be attributed to non-occurrence of PPH in these animals. **The antioxidant viz. acid @ 5-7.5 g alongwith sodium acid phosphate 60 g dissolved in 500 ml dextrose saline (5%) be given I/v daily for 3 days to treat post parturient haemoglobinurea (PPH) in**

buffaloes. Besides, liver tonics and mineral mixtures are also recommended to be given.

- **Avian rotavirus was demonstrated by RNA-PAGE and adapted to grow in cell culture for the first time in the country**
- Rota virus was found to account for 46.3 and 53.9% of diarrhoea cases in cattle and buffalo calves, respectively leading to heavy calf mortality. The techniques of RNA electopherotyping and **Dot- ELISA were adopted for diagnosis of Rota virus infections.**
- **Paste des petitis ruminantis (PPR) a viral disease of goats was recorded for the first time in Haryana with high morbidity and mortality.**
- **Seromonitoring showed alum precipitated HS vaccine under field conditions-immune response upto 6 months only. Repeated vaccination required.**
- Extensive epidemiological studies on bluetongue virus (BTV) and *culicoides* vector identification have been carried out in northern India. Dot-ELISA and cELISA based on monoclonal antibodies and recombinant antigen + (group specific VP7 protein) have been used for diagnosis of bluetongue.
- **Partial VP2 gene sequences of three Indian isolates of BTV-1 (Avikanagar, Sirsa 3 and Chennai) and coding sequence of VP7 gene of BTV-18 Bangalore isolate were cloned and sequenced. The DNA sequences have been accepted by the International Genbank database and are available online with Accession Nos. AY559058, AY559060, AY559061 and AY606206 respectively (website:http:/www.ncbi.nlm.nih.gov)**
- ***Salmonella* and *E Coli* are the major bacterial enteric pathogens causing diarrhoea in young calves.** The enterotoxins of these organisms have been biochemically, biologically and immunologically characterized.
- Efforts to develop subunit vaccine against salmonellosis using cell surface antigens of S*almonella typhimurium* and S.*dublin* have yielded encouraging results. For the diagnosis of S*almonella* infection, the Rose Bengal test using somatic and flagellar antigens has been extensively used.

- **Entertoxaemia** in camels in district Sirsa has been diagnosed for the **first time in the country.**
- **Incorporation of A 22 strain of foot-and mouth disease virus in vaccine**: A22 strain of FMD virus was isolated from the field outbreaks and got incorporated in the vaccine which saved life of millions of animals from this deadly disease.
- **Control of IBD vaccine failure in poultry:** Virus was isolated in the field and included in vaccine regime, which helped in saving the poultry worth millions of rupees.
- **Development of diagnostics for Bluetongue virus:** Helped in certification of animals and their germplasm for control of disease and export purposes.
- Infectious bursal disease virus (IBDV) one of the most dangerous poultry pathogen played havoc to the poultry industry throughout the country. Despite the vaccination, outbreaks occurred in poultry farms. This lead to the speculations that antigenically different strains may be present in the field. Comparative pathogenesis studies using Hisar and Hoshiarpur isolates suggested that Hisar/97 isolate of the virus was more virulent than Hoshiarpur isolate. **The viruses were successfully adapted to grow in BGM-70 cell line. This development would eliminate the need of primary culture of chicken embryo fibroblast which is more cumbersome.**
- **Equine herpes virus-1 is one of the important pathogen causing abortions in mares** leading to considerable economic losses to the army studs. To study the antigenic variations amongst the EHV-1 circulating in the equine population of the country, a panel of 13 MAbs was raised against abortigenic EHV-1 Hisar 90-7 strains and used for molecular comparison of EHV isolates. All the ten MAbs reacted specifically in various serological tests viz. ELISA, SNT, FAT and Western blotting. Of the 13 MAbs, two were found to be complement fixing. The availability of these monoclonal antibodies would facilitate antigenic characterization of new isolates of EHV-1.
- **Studies on comparative immunogenicity of combined FMD+HS vaccine and FMD vaccine alone revealed that buffaloes may be safely vaccinated with combined vaccine without impairing the immune response against constituent FMD antigens.**

- **200 mg-dry leaf powder of Tulsi was found optimum for chicken for better immune response and body weight gain.**
- The role of *Mycoplasma mycoides* **(LC variant)** has been established as a cause of bovine abortions for the **first time in the world**. Quick and reliable diagnostic tests for diagnosis of Mycoplasmal infections have been evolved.
- **A rough phase of Brucella abortus was found to be involved in abortions in buffaloes. A lipopolysaccharide (LPS) antigen based Enzyme Linked Immunosorbent Assay (ELISA) has been developed in sheep for detecting Burcella antibodies in milk. This test has been found more sensitive than milk ring test.**
- **Developed simple and quick tests** viz. co-agglutination assay. Dot-ELISA and counterimmuno-electrophoresis for detection of brucellosis in different species of livestock.
- **Abortions and foal mortality syndromes** associated with equine herpes virus type-1 and *Salmonella abortus equi* in equines have been controlled through diagnosis, and vaccination.
- **The phenolic extract of the horn cancer tissue has been successfully used as vaccine that enhances the immune status of the affected animals at early stages.**
- **A breakthrough was made in establishing the cause of increasing deaths in peacocks.** Unintentional insecticide poisoning through treated seeds was diagnosed as a factor causing mortality in peacocks.
- Prevalence of flukes and other intestinal nematode infections has been studied among milk producing animals. A bioclimatiograph of the parasitic diseases prevalence in the state has been evolved for forecasting the occurrence of parasitic diseases and their timely control.
- Coccidiosis in broiler chicken is the major parasitic disease. **Supplementation of additional calcium (1%) and zinc (60ppm) in feed proved beneficial and influenced, anticoccodial drug efficacy.**
- **Hepato-intestinal schistosomosis** caused by *Schistosoma indicum* in small ruminants in Haryana can be controlled effectively with **single dose chemotherapy with praziquantel @ 25 mg/kg b.wt. orally.**
- **Strongyloidosis** is a major helminthic problem in buffalo calves and the commonly used anthelmintics e.g. fenbendazole and morantel citrate

failed to control the infection. However, **invermectin at the recommended dose rate was efficacious** for the purpose, at the Buffalo Research Center of this University.

- The wasting form of **clinical ketosis** without nervous involvement was recorded in buffaloes. Therapeutic trials comprising of (i) Nandrolone phenylpropionate @ 0.7 mg/kg, I/M as single dose and (ii) Dextrose (20%) 1/Vplus insulin @ 0.25 mg. 1 U/kg body wt., I/M single dose were found to be highly effective in curing clinical ketosis in buffaloes.
- **The anthelmintics including doramectin, albendazole and fenbendazole were found ineffective against Sataria digitata located in the anterior chamber of mares. The comparison of three different surgical techniques used for surgical removal of setaria digitata revealed that paracentesis using scalp vein set 18G fitted in syringe and adhering of parasite in needle bevel using suction pressure and simultaneous withdrawal of needle alongwith parasite was 100% effective.**
- **Resistance of fenbendazole and tetramisole hydrochloride has been record against *Haemonchus contortus* in sheep in district Hisar. The resistant flock was, however, treated successfully with closantel. Since the resistance of fenbendazole and tetramisole hydrochloride is spreading against *Haemonchus contortus* one of the most pathogenic and highly prevalent parasites of sheep kept under unorganized sector, therefore, the use of these anthelmintics requires regular monitoring.**
- Complete anatomy of locomotive system of camel has been elucidated and will be of great help in treatment of surgical problems. Ultra structure and histomorphological studies on various organs of buffalo, camel and goat have been done.
- **A highly useful test for pregnancy diagnosis in buffaloes** and cows has been developed that allows pregnancy diagnosis as early as 20 days post service. A simple package of heat detection in buffaloes in organized farms has been developed giving an accuracy of 90%.
- **Poor fertility of buffaloes during summer season is a major hinderance to reproductive efficiency of this species.** Postpartum anoestrus buffaloes treated with melengesterol acelate @ 0.4 mg/head/day for 14 days or hydroxyl progesterone caproate @ 500mg s/c followed by 1000 to 1500 IU eCG. The 50% of the treated animals

conceived to first insemination. The estrus was recorded between 15 to 40 days post-treatment.

- **Assisted Reproductive Technology appears to be good for induction of cyclicity in buffaloes both in breeding and non breeding seasons, under rural conditions. With the use of Assisted Reproductive Techniques it should be easily possible to get three lamb crops in two years. This can lead to increase production by 50%.**
- **Post-insemination ultrasonographic monitoring in buffaloes revealed follicular development in 3 or 4 waves during 24 days post-insemination irrespective of pregnancy status.**
- **Repair of diaphragmatic hernia in buffaloes and management of fracture and treatment of bone infection have been perfected.** Various techniques for radiographic diagnosis of abdominal thoracic problems in large animals have been perfected. Safe and effective Preanaesthetics and anaesthetics for cattle, buffalo, camel, sheep and goat have been identified. These developments have great impact on the effective treatment of the surgical problems.
- **Buffaloes suffering from TRP have electrolyte imbalance** (especially hypochloraemia and hypokalaemia) and need extensive therapy with chloride and potassium supplements. These animals also develop caudal stomach disorders.
- **In buffaloes, diazepam was not found to be safe and thus its use not recommended.**
- Therapeutic effects of anti-oxidant treatments were evaluated in forty five buffaloes suffering from diaphragmatic hernia. Higher oxidative stress and lower endogenous anti-oxidant status were observed in these animals. Vitamin-E and selenium combination, ascorbic acid and dexamethasone, in that order, had good anti-oxidant effect and their administration proved beneficial. Administration of manganese chloride in these buffaloes proved counter-productive.
- Prophylactic efficacy of a short course of ciprofloxacin was evaluated in cow-calves with experimental bone infection. The dosage regimens i.e loading and maintenance doses of ciprofloxacine were found to be 5.1 and 5.0 mg per kg body weight, respectively to be administered i/v at 12 hours intervals. Ciprofloxacin showed better penetration in the bone

marrow and was available in concentration higher than M/C upto 6-8 hours after its single administration.

- **Formaldehyde fumigation gave good results for decontamination of airtight operation theatre. This treatment significantly reduces the bacterial load on inanimate objects. Scrubbing of operative site with Betadine (5% w/v) was found effective tropical disinfectant.**

Animal Production

- **Improved managemental practices** like sprinkling of water on the animals during extreme summer months, coolhour feeding, supplementation of mineral mixture, proper detection of heat have been tried and found to be very effective in reducing the age at Ist calving in Murrah buffalo heifers and reduced service period and calving interval in the post-partum lactating buffaloes.

- **For reduction in age at first calving in buffaloes, the balanced feeding (2kg concentrate with 25 grms of mineral mixture daily + ad lib. Green fodder) and by adopting improved management practices in summer such as water splashing 2-3 times during the hotter part of the day, coolhour feeding, provision of fresh drinking water and modified roofs to the growing buffalo heifers, puberty and maturity weight (300 kg) could be achieved at an early age of two years.**

- In order **to reduce intercalving period** ear implantation with CRESTAR. Folligon (PMSG)) was given 1/m and on 10^{th} day of implant removal. The result revealed 50% success in inducing estrous in animals during summer as well as winter.

- Establishment of a model Radio-Immuno Assay Laboratory and raising of antisera against bovine gonado-trophins has helped to carry out studies on plasma profile of gonado-trophins (FSH, LH and prolactin) sex steroids, cortisol and thyroid hormones of cycling buffaloes during hot and cold months, non-cycling buffaloes during hot season pre-and post-partum and different stages of pregnancy and lactation ELISA of milk progesterone profile of post-partum buffaloes revealed missing of estrous by routine management practices which was responsible for long service period. Use of CRESTAR ear implant followed by a small dose of PMSG gave encouraging results for induction of early ovarian cyclicity in post-partum anestrous buffaloes.

- **The administration of locally available hormonal preparations proved cheap and effective method of anoestrus treatment.** The feeding of mineral mixture @ 50 gm/hr/day was found effective in rectification of anoestrus problems in 50% of cases in buffaloes.
- **The use of membrane stabilizers (chlorquine diphosphate and chlorpromazine hydrochloride) to reduce leakage of intracellular enzymes has been standardized.** Removal of seminal plasma prior to deep freezing of buffalo semen was found to be beneficial in improving the survivability and acrosomal integrity of spermatozoa. Thawing of frozen semen at high motility and acrosomal integrity on subsequent incubation at 37^{o} C for various time intervals have been found successful.
- **Freezing of buffalo semen after filtration through sephadex G-100 Column of 1 cm length using T RIS buffer resulted in satisfactory level of progressive mortality and survivability of spermatozoa.**
- Rabbit peritoneal fluid as an alternate medium for *in vitro* maturation and fertilization of caprine embryos has been successfully used. This has resulted in reducing the cost involved in embryo transfer technology requiring use of expensive media. One calf using this modified protocol has been produced from Haryana surrogate mother.
- A short term treatment by administering Estradiol 17-β for **inducing milk in infertile cows** was standardized and perfected for adoption in the field at a nominal cost. In a trial, 9 out of 10 buffalo heifers responded positively and produced milk ranging from 400 to 625 liters in an average lactation of 227 days.
- **Cattle synthetics have been developed through infusion of exotic inheritance of Brown Swiss, Holstein Friesian, Red Dane and Haryana cows.** Productivity of the synthetics has been found to be of high order making them fit as a future dairy animal. Efforts are being made to stabilize exotic level at 50 to 62.5% with the ultimate aim of producing 3500 litres of milk in a lactation of 300 days.
- **In order to serve indigenous germplasm of cattle and buffaloes, germplasm centres for Haryana cattle and buffaloes have been established with a view to undertake sequential selection for gradual improvement of production.**
- For regular screening of breeding bulls and other livestock, chromosomal studies are being undertaken as associated attributes for selection of

animals. Studies have indicated that **low breeding efficiency of animals was related to their chromosomal aberrations and sister chrometid exchanges.**

- **A new strain of sheep having 50% exotic inheritance of Russian Merino, Corriedale sheep has been developed which produce ideal carpet wool. Germplasm of this strain has been stabilized and is being disseminated among the farmers of the state.**
- The role of biogenic amines in the mechanism of ovulation in chicks has been studied. These studies revealed (a) the involvement of catecholamines through alpha adrenergic receptors in *in vitro* ovulation, (b) that largest ovarian follicle contains more adrenaline and noradrenaline than does the next largest and (c) immature ovulation can be induced through LH and catecholamines in the hen.
- A cross layer strain of poultry has been developed which lays 275 eggs in a year and this layer secured **first position in the 24th RSPTC at Hessarghatta in 1993-94.**
- The study on effect of weight and duration of pre-incubation storage of turkey eggs on fertility and hatchability indicated that **turkey eggs weighing upto 79 grams had better fertility as compared to large sized eggs.** The management studies on Turkey pullets revealed that birds prescribed with high feeder space than 3 sq. inches per bird had better growth of the bird.
- Inter disciplinary approach on nutritional biochemistry, rumen microbiology, enzymology and physiology has been conducted in relation to nutrition of buffaloes and cattle. These distinctive differences on rumen bacterial isolates and protozoan ciliates between cattle and buffalo have been observed. These studies provided understanding and abridging the lacking information on digestive physiology and differential nutrient utilization between the two species.
- To accelerate the protein nutrition of animals, the crude protein and digestible crude protein of poor cellulosic feedstuff (wheat straw) by treatment with sulphuric acid under ammoniation process was found to enhance it by 17% and it reduced environmental pollution substantially.
- Economical analytical techniques for chemical evaluation (quality parameters) and biological evaluation (nutrient digestibility) of Indian fodders, straw and grass were developed.

- **The undersize grains viz. barley, ricebean, cotton seed, sunflower, guar etc. were chemically and in-vitro evaluated for their nutrition value. It was found that these could be fed to lactating dairy animals, poultry and swine as a source of energy and protein.**
- **Nutritional evaluation of various agro-industrial byproducts such as Guar gum industry byproducts, hominy feed, malt sprout, rice mill byproducts, ginning industry byproducts and fermentation industry byproducts has made it possible to exploit their use in compound feed industry for production of low cost balanced feed for various livestock and poultry species.**
- **Phulsi, a moong crop residue mixture consisting of broken and small size grains, empty pods and straw can be incorporated upto a level of 60% in the concentrate mixture of kids and lambs.**
- Green gram (Vigna radiate Linn) bhusa alone can maintain non-lactating sheep and goats. DM intake in sheep and goats was 3.42 and 3.16 kg/100 kg body weight. The DCP and TDN values were 5.37, 43.8 and 5.66 and 45.91 for goats and sheep, respectively.
- Nutritional evaluation of newly developed varieties of different forage crops i.e. Berseem, Sorghum, Oats, Chinese cabbage, Maize and hybrid Napier etc.
- The nutritional evaluation studies revealed that basmati paddy straw is better digestible in comparison to coarse variety of paddy straw and wheat straw. Treatment of paddy straw of coarse and basmati varieties with urea and/or lime decreased the cell wall contents and improves the DM and OM digestibility 2% urea + 4% lime combination was observed to be economical and optimum level of these chemicals.
- **The survey conducted in 10 districts of Haryana about the mineral status of buffaloes indicated a widespread deficiency of zinc. There is deficiency of calcium, phosphorus and copper to the extent of 50-75% in the districts of South Haryana. The calcium deficiency in Gurgaon district was found more critical.**
- **Least cost feed formulae based on locally available feed ingredients were developed.**
- Supplementation of 15 and 30% extra protein during last two months of pregnancy resulted in higher body weight gain and birth weight of new

born calves. Feeding 10% higher protein than the NRC requirements resulted in higher birth weight of calves of crossbred cattle.

- **Developed a densified complete feed block making machine in which two feed blocks can be made simultaneously.** Replacement of wheat bhoosa by chaffed paddy straw at 50% level improved the quality of feed blocks and was economical without affecting the performance of animals. Feed blocks made of urea treated crop residues are more dense and durable with low post compression expansion as compared to the blocks made of untreated crop residues. Urea treated wheat straw in the form of complete feed blocks when fed to heifers lead to a DM intake of 2.81 kg/100 kg body weight and 727.78 g daily body weight gain. The intake and weight gain are much higher than the normal values of 2.5 kg. and 550 g, respectively.
- **Technology has been developed to densify wheat and paddy straw to reduce to ¼th of its volume in the form of bales. It will help in reducing accidents in transport of protruding loads.**
- Groundnut cake may be replaced at 50% level with mustard cake without affecting the feed intake and body weight gain in the ration of growing lambs. Beetal goats may be maintained on Prosopis sp. (CP ranged from 12.4 to 18.3%) without any deleterious effects.
- **Multi-nutrient lick block production technology has been developed by utilizing exothermic reaction between calcium oxide, phosphoric acid and molasses**. The feed ingredients rich in energy and protein have been integrated in these blocks to make it more palatable and with high nutritive value. These blocks can be safely stored for one year in normal atmospheric condition and can be used as nutrient supplement for adult, growing and lactating buffaloes and cattle.
- Pelleted complete feeds were developed using non-conventional crop residues like *arhar, dhaincha,* cotton *moong* and *urd* stalks etc. for growing lambs.
- **Uromalt-40 and uromalt-20 were developed as protein supplements in place of costlier groundnut cake in compound feed production for ruminants.** Uromalt-20 can be used as sole concentrate after supplementation with mineral mixture and common salt.
- **Technologies for different meat and meat products have been developed which are suitable to our conditions.** These fall under the

category of fresh cooked meat products, shelf stable meat products (stored without refrigeration), coarse comminuted meat products and pickles. Among the important delicacies meat blocks sausages, tandoori chicken, meat based papads, quail egg pickle chicken kabab and meat patties prepared with egg mélange are unique and highly acceptable by the consumers.

- **Ready to cook and ready to eat chicken cutlets from broiler meat were developed** using maida, besan and bread crumbs (0.25, 5, 7.5 and 10%) each) following different cooking technique (deep and shallow frying). Chicken pickle using meat from spent hen with and without starter culture (P a cidilactici, L. planteram and in combination) were developed. The spices such as cumin, garlic, ginger, mustard, red chilli, turmeric and their mixture have natural potential for antimycotic activities.
- **To minimize oxidative changes and to improve the meat quality during refrigerated storage**, it is recommended to use tocopherol acetate at 8 ppm level in minced pork, sodium ascorbate at 700 ppm level and tocopherol acetate at 12 ppm level in minced mutton, ginger extract at 2% level and clove powder at 0.2 % level in minced chevon.
- **Low cholesterol khoa** with acceptable organoleptic quality could be prepared by replacing 50% of milk fat with vegetable oil and with 0.3% trisodium citrate. In khoa powder about 50% of cholesterol reduction was achieved.
- The University has established an automatic milk processing unit for conducting teaching and research. **The technology of whey carrot beverages** using 60.40% of carrot-juice and whey with 6% sugar was developed and was found to be most suitable palatable drink.

BASIC RESEARCH:

Biotechnology & Molecular Biology

Micro-propagation:

- Initial success has been achieved in plant regeneration in a few selected cotton cultivars (H1098, H1117, H777, HS6, RST9, RS875, Ankur651, F846 and LHH144). Efforts are under way to improve the efficiency of regeneration and subsequent transfer to potted soil.

- Regeneration has been successfully achieved in five genotypes of wheat (HD29, HD2009, WH157, PBW343, WH533).
- Micro-propagation of sugarcane varieties, CoH92, CoH99, CoH101 and CoH110, was again carried out using shoot tip explants and plants are being maintained for the demonstration purpose.
- Micropropagation of ornamental plant species such as Chrysanthemum (Snowball, Ghenghish Khan, Dignity, Kikubiori, Temptation and Silk brocate), gladiolus and orchids was carried out using the already-established procedure.
- The cultures initiated from field grown trees of female datepalm are being maintained and multiplied. Some plantlets have been transferred to experimental area in the farm.

Transgenics

- In rice, transformation experiments were conducted to transfer Potato protease inhibitor II (Pin2), and barley late embryogenesis abundant protein (Lea3) genes in Basmati rice varieties, Pusa Basmati 1 and Taraori Basmati; A Japonica rice variety TNG67 is used as the control. A. tumefaciens strains containing useful genes (Pin2, Lea3) driven by a suitable promoter (Pin2', Actin 1. In, ABRC) were used for the rice transformation. Callii derived from mature seeds and/or immature embryos were used. Over 200 hygR plants have been obtained from these Agrobacterium transformation experiments. About 40 plants have been transferred to the pots in the transgenic greenhouse facility developed in 2000-2001. Further molecular and progeny analyses of these plants are in progress.
- Medium requirements and culture conditions have been standardized for plant regeneration from radicle explants of embryo axis, immature cotyledons and leaf explant of the in vitro grown seedlings & field grown chickpea plants. Some success has been achieved in transferring regenerated plantlets to the potted soil. Transient GUS expression at high frequency has been obtained in embryo axis derived chickpea tissue cocultivated with Agrobacterium strains containing GUS gene as a marker. Over 125 transgenic chickpea plants have been produced and characterized on the basis of molecular analysis. The putative transgenic plants containing Bt., Pin II and Manitol de-hydrogenase genes await transplantation to potted soil.

DNA Fingerprinting

- Laboratory facilities and protocols have been developed for the DNA fingerprinting of rice varieties using RAPD, AFLP, ISSR and microsatellite (SSR) DNA markers. A simple and cost-effective procedure has been developed for the isolation of DNA from milled rice samples, which contains higher amounts of starch and RNA contents.
- A DNA fingerprint database of 24 rice varieties including commercially important Basmati varieties, has already been developed using fifty microsatellite DNA markers well distributed on the 12 rice chromosomes.
- RAPD markers proved highly successful in characterizing the individual chickpea genotypes which are in consistent with their pedigrees.

Molecular Mapping

- SSR marker analysis was successfully used to confirm the hybrid nature of F1 hybrids obtained from Taraori Basmati x CSR10, Taraori Basmati x Pokkali, Taraori Basmati x Azucena and Taraori Basmati x New Plant Type II crosses.
- Thirty SSR markers were screened for Anthracnose resistance locus in sorghum. SSR marker Xtxp61 and Xtxp212 amplified a fragment of 550 bp and 700 bp, respectively were found linked to the locus conferring resistance.
- SSR markers were more efficient that RAPD markers as 63% of SSR markers differentiated between the genotypes, whereas, only 39% of the RAPD markers were able to differentiate the parental genotypes.

Value Added-Micro Organisms / Products

- Cloning of cry IA(b) gene in E.coli : Work is in progress for the isolation of total DNA of B. thuringiensis strain L-10, L.33 and S-14.

Microbiology:

- Technology for the production of wine from locally grown grapes has been developed and technical know-how for large scale production of wines was transferred to Panipat Co-op Distillery, Panipat, Haryana.
- A fast fermenting yeast strain HAU-1 was evolved which ferments Indian cane molasses to 8% ethanol (v/v) within 24 h . The strain is presently being used/bought by various distilleries in India, at a price

of Rs. 5000/- a slant. Using the strain HAU-1, a process of recycling of biomass that trims up the fermentation time to 12-18 h, was developed .

- A process including the yeast strains for fermentation of grains to 10% (v/v) alcohol within 24 hours at 30^0C and 40^0C and, 8% (v/v) at 45^0 C, has been worked out . Yet another fermentation process to produce 10% (v/v) ethanol within 24 h from spoilt (moldy) wheat has been worked out. It suggests that healthy wheat is not as good a raw material for ethanol production as the spoilt one is !
- Solid state fermentation process for the production of citric acid from cane molasses has been developed.
- Protocol for production of enriched manure from organic wastes by incorporating rock phosphate and microbial inoculants has been developed is being tested.
- Effective strains of biofertilizers for legumes, cereals, millets, cotton, oilseeds, sugarcane and vegetables have been developed and are being supplied to the farmers. These include Rhizobium, Azotobacter and P-solubilizing bacteria. So far department has produced about 25 lakh packets of various biofertilizers.
- A solid state biogas plant for production of gas from undiluted cattle dung has been developed and demonstrated at farmers' fields. Recycling of 10% spent slurry during winter months in KVIC biogas plant have shown increased biogas production. Brackish water can be safely used for making cattle dung slurry for biogas production.
- Microorganisms for the bioremediation of textile dye effluents and distillery spent wash have been identified.

Botany and Plant Physiology

- **Transplantation technique** to improve stand establishment in cotton under Salini Conditions has been perfected and tested.
- Activity of antioxidant defence system is closely related to root nodule functioning and their senescence in pigeonpea and chickpea, thus determining contribution of the symbiotic system towards N-economy of the plant. High activities of ascorbate peroxidase and catalase appear to indicators of high N_2-fixation in the nodules. Exogenous application of ascorbic acid to the plant can partially alleviate the adverse effects of salt stress on nodule functioning.

- In wheat, pigeonpea and faba bean salinity and boron tolerance went hand in hand.
- Bajra hybrids having medium leaf weight and thickness were found high yielders.
- Pigeonpea genotypes Paras and H90-10 which showed high P-use efficiency were also resistant to waterlogging.
- Uptake of heavy metals is higher in root vegetables.

Genetics

- New plant ideotypes of urdbean (Amp 36, 56, 92) and mungbean (Amp 45, 56) have been developed from amphidiploid of mungbean x urdbean crosses. One of the new plant ideotype Amp 36-13 was registered with NBPGR, New Delhi (Registration No. INGR No. 02208).
- In wheat, genetic analysis of crosses involving dwarf sources (Norin 10-Nar 59, S948A1 and Tordo) and Tall genotype (C306M10 and C591) was done. Dwarf near isogonics lines incorporating Rht-1, Rht-2, Rht-3 in the genetic background of C306M10, C591, K 68, Kharchia 65 have been developed and two lines viz. DI 9 and DI 105 have been got registered with NBPGR, New Delhi (INGR 99002, INGR 99001). C306M10 has been characterized as non-carrier of necrotic genes and registered with NBPGR (INGR 99018).
- The RILs SG 15, SG 22 and SG 8809 have been got registered with NBPGR as new germplasm (INGR 99003, INGR 99004, INGR 99005).
- Kabuli gram variety 'Gora Hisari' was released in Haryana state for cultivation.
- Protocols have been developed for multiplication of Rauwalfia serpentina and Glycyrrhiza glabra.
- Low doses of gamma radiations has been found to stimulate germination in freshly harvested dormant seeds of wheat, barley and triticale.
- Cytological analysis of Holstein cattle (exotic) revealed 2n=60 (XY-male). The X and Y chromosomes are submetacentiric. White leghorn breed of chickens possessed 2n=80.
- Genetic and cytogenetic effects of food additives and some agrochemicals have been observed in barley, mouse and Drosophila. Carbaryl, lindane, sevidol, deltamethrin, bavistin, epichlorhydrin,

nurelle-D, triazophos, alphamethrin, isoproturon and trifluralin proved to be clastogenic in barley, cytotoxic in mouse and induced mutations in Drosophila.

- Mutant of *Trichogramma* tolerant at 39°C isolated. Also chromosome number in T. chilonis determined to be n=5 males and 2n=10 females.
- Colchicine inducted tetraploids of *desi* cotton cv. H-17 were cytologically analyzed and two plants were found having chromosome number 2n=52 and 2n=50.
- Five multilines of WH 147 and Kalyansona were developed. New variability for leaf rust resistance involving WH 147, WH 157 and Kalyansona has been created.
- The research work has been initiated to identify markers for Karnal bunt resistance in wheat. Out of 46 SSR primers and 92 RAPD primers used for studying polymorphism, three and two were found to be associated with Karnal bunt resistance.
- Mutation induction studies have been initiated on medicinal plants like isabgol, ashwgandha and satavari, berseem, cotton and forest tree (Prosopis juliflora) for creation of genetic variability for desired traits.

Chemistry and Physics

- The following plants i.e. Dodonaea viscose, Pakinsonia aculeate, Rhamnus virgata, Cassia spp. (C. alata, C. didymobotrya, C. glauca, C. biflora and C. nodosa), Melia azedarach, Acacia arabica and Pongamia pinnata have been studied for their chemical constituents.
- It has been shown that PAH level in the soil sample from Faridabad is the highest amongst the soil samples studied. Microemulsion having composition of 2 % oil and 40 % Brij-35 in aqueous medium is found to be most efficient for the removal of PAH from the soil.
- Xanthomolides from Xanthium strumarium and long chain alcohols from Argemone maxicana were isolated and characterized. The studies on neem (Azadirachta indica A. Juss.) provenanees for azadirachtin contents were carried out on the samples of north-India states.
- Various substituted aldehydes, ketones, esters, phenols and amines were tested for nematicidal activity against the root knot nematode, Meloidogyne javanica. Among aldehydes three compounds viz.,

benzaldehyde, 4-bromobenzaldehyde and cinnamaldehyde exhibited 100% mortality at 125 ppm concentration.

- Microwave assisted organic reactions have been studied for different type of reactions like addition, condensation, elimination, oxidation etc. MW assisted reactions are eco-friendly in nature.
- Physico-chemical properties of some aqueous surfactant solutions were determined.

Biochemistry

- Detailed studies on wheat, chickpea, pigeonpea and *Brassica* have led to the development of following:
- A mechanism of biosynthesis of starch in amyloplasts of developing wheat grains
- A pathway for the biosynthesis of ureides in pigeonpea nodules.
- Detailed budgets for carbon and nitrogen for the entire life cycle of chickpea and pigeonpea.
- An in vitro system for fatty acid biosynthesis with leucoplasts of developing seeds of Brassica campestris.
- Pathway for CO2 fixation in reproductive parts of cultivated crops.
- Biochemical studies on wheat v/s brown rust, wheat loose smut, pearl millet v/s downy mildew and *Brassica* v/s *Alternaria brassicae* have suggested the involvement of phenylalanine ammonia lyase, tyrosine ammonia lyase, peroxidase, IAA oxidase in disease resistance.
- Experiments on chillies v/s fruit rot pathogens resulted in the production of anti fungal compound capsidol, the elicitor of which has been found to be a polysachharide composed of mainly glucose, galactose and mannose as monosachharides
- A number of Breeders' material comprising of cereals, pulses, oilseeds, fruits and vegetables has been analysed for the desirable and undesirable nutritional attributes.
- An *in vitro* liquid culture system has been developed to study lipid metabolism in *Brassica campestris*.

- Studies on various abiotic stresses on plant metabolism have revealed nitrogen metabolism, mineral nutrition and overall plant growth to be adversely affected with the application of heavy metals.
- Various aspects of N_2 fixation viz., early events of nodulation, expression of nitrogenase, symbiotic benefits of Hup^+ strains of rhizobia, influence of various carbohydrate sources on nitrogenase activity have been studies in *Rhizobium meleloti*, *R. mungbean* and *R. leguminosparum*.
- Reactive oxygen species (ROS) and their scavenging enzymes have been shown to play an important role in providing resistance against sodicity / salinity
- Increase in activities of cell wall degrading enzymes and decrease in the activities of ROS scavenging enzymes have been observed to be requisites for mediating metabolic changes occurring during fruit ripening and storage.

Mathematics and Statistics

- The super-population approach has been extensively used to study the relative efficiencies of various sampling strategies under the linear models. Non- linear super-population models based on simple random sampling and Midzuno-Sen system of sample selection, the difference estimators and pps estimators have been examined.
- The efficiencies of the different sampling designs have been compared in cotton crop. Two-stage sampling designs with primary stage unit (villages) were found to be more efficient in comparison to previous years' data.
- In grapes, two stage simple random sampling strategy in which primary stage unit (orchards) and secondary stage unit (plants) both were selected by simple random sampling was found to be more efficient.
- A manual on "Design of Experiments" was published which is very useful to the research workers of the different disciplines regarding designing and analyses of experimental data.
- Regarding Ber Crop, the average sampling variance of the sampling design in which Ber plants were selected with simple random sampling after stratification, was found to be more efficient than other sampling designs.

- For developing suitable models on the time series data, the work was pursued on the secondary data on area, production and productivity of paddy, a American cotton, desi cotton, wheat, bajra, sugarcane, barley, gram and rapeseed and mustard.
- Statistical consultancy to the students and research staff of HAU is also a major part of the work of the scientists.
- The scientists conducted two 4-weeks trainings to the teaching, research staff of SAU's, ICAR institutes etc. on the topics -a) Use of statistical methods in agriculture and allied fields-b) Designing and analysis of field experiments, Manual on these two topics were also published.
- Models for forecasting the yield of cotton on the basis of bio-metrical characters has been developed.

WOMEN EMPOWERMENT SECTOR

Clothing & Textiles

- **Standardized anthropometric measurements and bodice block for the following age groups:**

  * 1-2 yrs. * 2-4 yrs * 4-6 yrs * 6-8 yrs

- **Standardized anthropometric measurements of women and Developed paper patterns for :**

  * lady's kameez for various bust size (32", 34",36" & 38" : 21 paper patterns)

  * Girls top (10 paper patterns)

- **Developed kameez designs for expectant and lactating mothers**
- **Developed Functional garments for the physically challenged males and females having following disabilities**

  * Callipers users * Crutches users * Wheel chair users

  * Upper/lower limb fractured * Upper limb amputees * Lower limb amputees

  * Bothupper limb amputee * Paralytics * Muscular Dystrophy

  * Parkinsonisn * Cerebellar degenration

- **Developed educational package for :**

  * functional garments for amputees and poliomyelitis

  ***Consumer and consumer education** *** Care and maintenance of garments**

- Standardized Dyes conditions for dyeing of fibres of pure wool, cotton and silk yarn and developed various shades of brown, peach, beige, yellow, orange using following natural dyes:

  * Black kikar bark * Barberry bark, * Rein wardtia flowers
  * Neem leaves, * Burgad leaves, * Jatropha flowers,
  * Pili kaner flowers, * Kasood bark * Kachnar bark
  * Double coreopsis flowers * Ornamental mustard leaves

- **Standardized recipes for printing on cotton using natural dyes viz**

  * Double coreopsis flowers * Mango bark * Catechu bark
  * Rose flowers * Pipal bark * Marigold flowers

- Developed techniques of resist dyeing using new resist objects and material
- **Developed designs for household articles using combination of weaves**
- Developed stylized designs for durrie and other utility articles with the combination of prevalent and traditional designs
- Developed stain removal techniques for fresh and old stains using different chemicals and household methods
- **Documentation of traditional costumes of following communities of Haryana:**

  * Jats * Bania * Ahirs * Ror * Bishnoi

Human Development & Family Studies

- Data base on traditional child rearing practices throughout Haryana
- Develop and standardized educational package on scientific child rearing practices for rural parents.

- Developed Home Based Intervention for overall development of children up to 6 years.
- Development of developmentally appropriate curriculum for preschoolers.
- Developed educational package for parents and teachers on social problem solving skill in children
- Developed and standardized tests to measure cognition, social cognition, special cognition and emotional cognition.
- Developed parent teaching strategies for problem solving.
- Intervention package for promotion of cognitive skills in slow learner.

Family Resource Management

- Improved smokeless chulah was developed and popularized.
- The most drudgery prone activities in home sector were fetching water, cooking and bringing firewood whereas in farm sector these were inter culturing, cutting/uprooting and post harvest activities. Under animal husbandry fodder collection, feeding animals and cleaning shed were the most tedious jobs.
- Ergonomic assessment of physiological workload of farm women in most drudgery prone activities viz. fetching water, weeding, fodder collection, cotton picking and washing vessels
- Rural women collected 20.24 kg of cotton per day during 4-5 cycles of cotton picking traveling a distance of 5.7 km in 5.45 hrs of total activity. Cot bag was designed and developed to reduce drudgery in cotton picking.
- Pro-mask was designed to protect the women from husk and dusk reducing her drudgery during wheat harvesting.
- Improved sickles after testing were introduced in villages for wheat harvesting and fodder cutting which increases the output by 23 percent and reduces the drudgery by 30% .
- The MDV woodstove was developed in which smoke generation, quantity of pollutant released the fuel-burning rate and specific fuel

consumption was decreased. The thermal efficiency was almost doubled (20.2%) along with increase of power output by 31.06% and total heat utilized by 39.27% as compared to traditional chulha.

- Developed a Zero energy chamber to enhance keeping quality of perishable food items.
- Prototype papad and wadi maker were developed which reduced the physiological stress on women and also increased the output capacity of the workers upto four times in wadi maker and two times in papad maker
- Developed a kit for adulteration detection in food items at household level.
- Proper utilization of organic waste at household level through vermicomposting.
- Mass trainings on smokeless chulha in three villages were conducted under IREP sponsored by Department of Non-conventional Energy Sources.
- Anthropometric measurements of 1000 Haryana rural women were studied along with compilation of data of 6000 rural women from all the AICRP centres of India.

Foods & Nutrition

- Weaning foods developed from locally available food stuffs using household technologies like roasting and malting have been found acceptable to infants and their mothers.
- The technology for development of potato flour, amylase rich flour and bread making was standardized.
- Different processing and cooking methods like soaking, dehulling, germination, pressure cooking, solar cooking and fermentation improved in vitro protein and starch digestibility and HCl-extractability of various minerals and decreased the level of antinutritional factors in various cultivars of cereals and pulses..
- Storage of pearl millet flour revealed that oxidative degradation of lipids was the main cause of deterioration of bajra flour. Blanching of grains for 30 sec increased the shelf life of bajra flour.

- Various pearl millet diabetic products including biscuit, idli mix chapatti, mix and pasta have significantly lower glycemic index (GI) than their respective control.
- Various value added traditional products and snacks prepared from pearl millet, soybean ,maize, barley, cowpea, fieldpea, green leafy vegetable powder and red palm oil have been developed and found to be acceptable and nutritionally superior.
- Less commonly consumed foods of Haryana State were identified and nutritionally evaluated. Bhakri, santhi, gullar, peehl, kondra and choulai were found to be rich sources of calcium, β-carotene and vitamin C. Kachri, baad karela, cluster bean and sem bean were good source of crude fibre.
- Products prepared by utilizing medicinal plants (banyan bark, bel fruit, bittergourd, fenugreek seeds, gurmar leaves, jamun seeds and omum) were found to be acceptable and resulted in significant increase in serum insulin and HDL cholesterol.
- Food samples including cereals, pulses, green leafy vegetables, fruits, roots and tubers etc. from different agro-climatic zones of Haryana State were screened for iodine and fluoride content.
- Dietary surveys of Haryana State revealed that 72% of girls and 80% of pregnant women were anaemic.
- Intervention studies were carried out for prevention and control of iron and vitamin A deficiency among rural children. An improvement in Hb, serum retinol level and weight of deficient children was observed as compared to control children.
- Food consumption data of preschool children indicated that mean daily nutrient intake i.e. calories, protein, niacin, riboflavin, iron, vitamin C and vitamin A was significantly lower than RDA among the preschool children of both sexes in 9 districts of Haryana.
- Ready-to-eat breakfast foods using different cooking methods have been developed.
- Method for rabadi preparation from pearl millet and other cereals has been improvised so as to retain the enhanced nutritive value which occurred due to fermentative changes.

Social Sciences:

The University has constituted social science group involving Deptts of Sociology, Agricultural Extension, Home Science Extension and Veterinary and Animal Science Extension. The mandate of this group is to study the adoption of technology, constants in the adoption of technology and also to identify the emerging needs of the farming community. The major accomplishments are:

- University regularly provides data on cost of cultivation to the Ministry of Agriculture, Govt. of India for fixing the support price of major crops.
- Technological gap and constraints in Bajra production were identified. Adoption level and constraints in popular based agro-forestry were ascertained. Constraints and management of rice-wheat cropping system were find out. Status of communication media used by farmers and extension officers in transfer of technology and technology application was ascertained. Constraints were identified for diversification in farming system of Haryana. Extension management strategy was developed for sustainable development of dry land agriculture. Problems and prospectus of fruit and vegetable growers in diversified agriculture were ascertained in Haryana.
- Suitable Media mix was developed to communicate agricultural technologies to farmers with special reference to dry land tract, cotton, sugarcane and rapeseed and mustard crops. Suitable training prototypes were developed for SDAOs, SMSs, CAOs, ADOs in relation to different crop practices. Suitable training prototypes were developed for DHOs and HDOs in relation to different vegetable and fruit crops practices.
- Training needs of SDAOs, SMSs, CAOs, ADOs, DHOs and HDOs were identified. Functional problems perceived by DHOs and HODs were identified. Communication pattern and source credibility perceived by District Horticulture Officers were ascertained.
- Skilled training to adolescent girls and rural women was imparted on improved home practices, energy saving and income generating activities. Training Model was evolved which comprised of the components of need assessment, pre-post of KAP, feedback and monitoring and evaluation. More than 3000 respondents of about 103 villages of 8 districts of Haryana were covered.
- Package on safe storage of grains and seed was prepared; synchronized slides (250) on improved home practices were developed. Testing and standardization of slides was done on field functionaries; appropriate

knowledge was given on ventilation, rural sanitation, Kitchen management and social forestry; time energy saving devices were induced in rural areas through action research and adoption feasibility was assessed; awareness on consumer rights and responsibilities was created among rural masses; training on health and sanitation was given to target group of backward classes through intervention programme; department coordinated the activities of technical staff and field staff for group formation, action plan and enterprise identification; electronic media was prepared on nutrition, animal husbandry, health & sanitation and Science & Technology.

- Data base of 3000 rural women respondents was explored on decision making, participation and time use pattern in home, farm and livestock management. Indigenous knowledge was identified on dairy herd management, maternal care, post-harvest storage of wheat, storage practices and medicinal plant for health security.
- Trainings were imparted on drudgery reduction activities, ergonomic cost of agricultural implements was worked out. Eighteen self-help groups were formulated in eight villages of Hisar district. Skilled training was imparted for various levels of groups in villages.

Outreach Research Stations:

Regional Research Station Bawal:

- This research station helped in the development and release of a number of varieties developed by CCSHAU. Coordinated and station trials are conducted of advanced material every year and data is provided to concerned Plant Breeder as well as to Coordinator. RB 24 of Mustard was exclusively developed at this station and the same was released.
- Package of Practices were developed for all the crops predominantly cultivated in south west Haryana, which include pearlmillet, clusterbean, mustard, gram, taramira, fenugreek, cotton and *durum* wheat.
- Desi cotton performs better than American cotton and first fortnight of April sowing is recommended for this region. Sprinkler irrigation method is better than traditional irrigation system. Drip system is better for establishment of horticultural and forestry crops. In light textured soils, sodic water upto 12 me/1 of RSC with Gypsum as amendment can be safely used for pearlmillet, wheat, mustard, desi cotton and sorghum.

Suitable preventive and remedial measures for different insect-pests and diseases in field and fruit crops have been developed.

- Crops found suitable for diversification are Coriander, Chandarsur, Fenugreek, Isabgol, Aonla, Karonda, Phalsa, Fennel and Ber.
- Maturity stages for preparing bael preserve, dehydration and squash have been standardized. Techniques for preparing various products like Lasora pickle, Phalsa squash, Mulberry squash, Aonla preserve, Ber and Karonda candy have been developed.
- RRS, Bawal provides good quality seed of major crops to the farmers of the region. Besides, nursery plants of ber, aonla, mulberry, bael, guava, karonda and phalsa are also supplied to the farmers.
- The Station has developed expertise for the preparation of bael squash, aonla preserves and ber candy. These products are sold at the station.

Regional Research Station, Karnal

- Variety COH 92 developed at RRS, Karnal was released in early group at the State and National level. Var. CoH 119 has been identified for mid-group and is highly promising. Var. CoH 110 has been identified for late group and is to be released. CoH 56 and CoH 99 varieties have also been developed and released in the state. High yielding and disease resistance single crop hybrids of maize namely, HHM-1 and HHM-2 were developed and released. Another hybrid HM-4 having orange colour and HM-6 identified for both seasons (winter and kharif). Nationally superior hybrid HQPM-1 has been developed and been tested at farmers' fields.
- Paired row planting of sugarcane was found superior to conventional method. Trash mulching was found to reduce irrigation, fertilizer and weeding requirements of ratoon crop.
- 50 kg P_2O_5/ha and 50 kg K_2O/ha showed substantial increase in cane yield in both sugarcane plant and ratoon crops. 75 kg K_2O/ha significantly increased the CCS Haryana Agricultural University%.
- The station has the distinction of developing an augmentive biocontrol for leaf hopper, *Phyrilla perpusilla* a sporadic but serious pest of sugarcane. This has saved the state several crores of rupees. A cottage system for the economical mass production of *Trichogramma* spp. developed. The technology has recently been transferred to sugar factories of the state.

- Variety Co 7314 was identified as source of red rot resistance. Three red rot pathotypes viz. CF01, CF02 and CF03 isolated from Co 1148, Co 7717 and CoJ 64, respectively have been identified.
- A technique developed for planting of sugarcane setts, which advances germination by 7-10 days and enhances germination rate by 30% has now become a farmers practice.
- New herbicides, Sulfosalfuron (Leader) at 25 g a.i./ha fenoxaprop (Puma super) at 120 g a.i./ha and clodinafop (topic) at g a.i/ha applied at 30-35 days after sowing recommended for the control of resistant biotype of *Phalaris minor* in wheat recommended.
- Simple and efficient protocols for mass multiplication sugarcane genotypes developed. Micro propagated plants showed high tillering and thus a poor tillering var CoH 92 had nearly double the number of tillers compared to normal sett grown plants. This eliminated main impediment in this otherwise early, high yielding, high-sugared and red-rot resistant variety.

Rice Research Station. Kaul

Haryana has become an important rice producing state. It ranks 3rd in productivity after Punjab and Tamilnadu. It has major contribution in basmati export to the tune of Rs. 1500 crores. All this has become possible, because of the development and release of improved rice varieties, production and protection technologies.

- Medium duration (136-150 days) rice varieties viz., HKR 120, HKR 126; early duration (100-120 days) variety HKR 46 and super-fine grained export quality varieties Taraori Basmati and Haryana Basmati-l have been developed and released for commercial cultivation in Haryana.
- Medium duration rice varieties IR 8, Jaya, PR 106; mid-early duration (121- 135 days) varieties Patman 579, IR 64; early duration varieties Govind, Pusa 33 in early duration and a scented variety Basmati 370 have been introduced for general cultivation in the state.
- An early maturing variety HKR 47, scented variety Haryana Mahak 11 and a hybrid HKRH 1 have been identified and proposed for release. Another hybrid HKRH-2 (medium duration) and HKRH-21 (early duration) have been identified for release.

- Medium duration non-scented high yielding varieties cover 55-60%, mid early and early duration about 8-10% while basmati varieties cover 30-35% rice area of the state.
- The strains HKR 99-18 and HKR 99-60 in early, HKR 99-37, HKR 97-38 & HKR 2000-55 in mid-early and HKR 95-222, HKR 96-89 and HKR 98-21 in medium duration group and HKR 98-476 in basmati group have been found to be promising.
- Optimum time of transplanting for medium duration, early duration and basmati rice varieties has been found to be June 15 to July 7, June 15 to end of July and 1st fortnight of July, respectively. If transplanting is delayed, 50-55 days old seedlings should be planted.
- Planting of Pus a 33 followed by basmati 370 and wheat was found profitable over one crop of rice followed by wheat. However, keeping in view the declining water table and build up of insect-pests and diseases, the cultivation of summer crop of , rice is discouraged.
- The total productivity (rice wheat equivalent) was recorded maximum (183.1 q/ha/year) with rice-potato -sunflower, but maximum return over variable cost was observed with rice (scented)-sunflower. The return of 10.1% higher was recorded with the use of green manuring of Dhaincha between wheat and rice in sequence over fallow-rice-wheat. The productivity of 113.8 q/ha/year was I obtained with rice-wheat rotation.
- Rice grain yield was significantly superior with the incorporation of residues of both rice and wheat crops over their burning and removal. The wheat grain yield of 49.2 q/ha was obtained with incorporation of residues in the fourth year as against burning (44.7 q/ha) and removal (43.0 q/ha) of crop residues. An increase of 13.5% in productivity of rice + wheat was recorded with the incorporation of residues of both crops over their removal. Organic carbon and total N contents in the soil increased with the incorporation but decreased with the burning of crop residues.
- The recommended doses of N, P, K and zinc sulphate are 150:60:60:25 kg, 90:30:30:25 and 60:30:30:25 kg for medium duration (HKR 120 & HKR 126), semi-dwarf basmati strains (Haryana Basmati-1) and tall basmati varieties (Basmati 370 and Taraori Basmati), respectively.
- Under integrated nutrient management in rice-wheat sequence, the highest grain yield (34 q/acre) of paddy (variety HKR 120) was obtained

where FYM was applied @ 4 t/acre with 48 kg N/acre. With burnt rice husk (3 t/acre) and summer fallow the highest grain yields were 33.6 and 31.3 q/acre, respectively at 64 kg N/acre. The highest grain yield with green manuring of Dhaincha and 32 kg N/acre was 32. 7q/acre. In control plots about 3.8, 9.9 and 14.8 q/acre extra grain yields were obtained in Ash, FYM and Dhaincha plots over summer fallow plots where no nitrogen was applied.

- The submergence (5+2 cm) of rice crop up to panicle emergence and saturation thereafter was more economical over the continuous submergence. The last irrigation could be stopped 12 days before harvesting.
- Resistant sources for major diseases viz. BLB, blast and stem rot have been identified and are being used in resistance breeding programme.
- Planting of basmati varieties before mid-July, avoiding water stress at panicle emergence stage and application of tricyclazole (Beam/Sivic) at 120 g/acre or edifenphos (Hinosan) at 200 ml/acre or carbendazim (Bavistin) at 200 g/acre at panicle emergence have been recommended for management of blast.
- For the control of bakanae, seed soaking in MEMC (Emisan) or carbendazim (Bavistin) at 1 0g/1 0 l water per 10 kg seed for 24 h and uprooting of rice nursery in standing water have been recommended.
- Avoiding late top dress of N particularly at booting stage and application of the copper oxychloride at 500 g/acre at 50% panicle emergence stage has been recommended against false smut
- For the control of WBPH, the spraying of endosulphan 35EC (350 ml), dichlorovos 76EC (Nuvan 125 ml), monocrotophos 36SL @ 250 ml in 200 1 of water /acre or dusting of methyl parathion 2% (Folidol) @ 10 kg/acre and broadcasting of dichlorovos 76EC 250 ml diluted in 1.5 1 water mixed in 15-20 kg sand in standing water is recommended.
- For leaf folder, spraying of 350 ml endosulphan 35EC or 200 ml monocrotophos 36SL or 400 ml quinalphos 20AF in 200 1 of water/acre or dusting with methyl parathion 2% @ 10 kg per acre is recommended.

- For the management of stem borer, a devastating pest of basmati rice, spraying of 500 ml methyl parathion 50EC (Metacid) or monocrotophos 36 SL or 1 litre chlorpyriphos 20EC (Durmet/Lethal) in 200 litres water/acre or broadcasting of 7.5 kg cartap hydrochloride 40 (Padanl Sanvex/Caldan) or fipronil 0.30 (Regent) mixed with 10 kg sand in standing water has been recommended at 30, 50 and 70 days after transplanting.

- Foliage pruning after 45-55 days (10-15 cm above upper most collar level) of transplanting is recommended to reduce plant height and avoid lodging in tall stature basmati varieties.

Other Stations:

The Research Stations at Rohtak, Ambala, Sirsa, Buria, Khirndwa also help in verification and development of technology for the respective zones. In fact, these stations were helping the Regional Research Stations in the development of technology for the zone. Balsamand Station was able to develop efficient technology for he sand dune stabilization.

IMPACT OF RESEARCH DEVELOPMENTS

Haryana was the food deficit state at the time of its inception in 1966. Within a short period, the state has emerged as a major food bowl of India. The technological changes resulting from research and development in agriculture have laid down the strong foundation of state economy. The growth of Haryana is identified with its agriculture because the contribution of agriculture in the State domestic product is still around 29 per cent as compared to 24 per cent for India. Prosperity of the people of the state therefore depends on the prosperity of agricultural sector. The economic growth mediated by technological changes in agriculture provided an overall increase in per capita net state domestic product. CCS Haryana Agricultural University played a key role in reshaping agriculture in Haryana.

Changing Scenario in Crop Production:

The production and productivity of the state agriculture have increased significantly. The production of rice increased 11 times, wheat more

than 6 times, rapeseed and mustard more than 9 times, American cotton 8 times, sugarcane (Gur) has doubled. Productivity of all crops has increased. The total foodgrain production which was 26 lakh tonnes in 1966 increased to 132 lakh tonnes in 2002-03 which is more than 5 times. In 1966-67, the major *kharif* crop in the state was pearl millet occupying nearly 48% area in the season followed by sorghum (15%), rice (10%) and cotton (10%). Sugarcane, maize, *kharif* pulses and *kharif* oilseeds occupied 8%, 5%, 3% and 1% area, respectively. This pattern has drastically changed. Now, rice occupies 34% of cultivated area in *kharif*, followed by pearl millet (27%), cotton (24%), sugarcane (6%), sorghum (5%), *kharif* pulses (3%) and maize (1%). Such shift has also been observed in *rabi* cropping pattern. In 1966-67, the cultivated area under various crops was 33% wheat, 48% chickpea, 9% oilseeds, 8% barley and 2% other *rabi* pulses. Now the area under wheat has risen to 64% followed by 19% mustard, 14% chickpea and 2% barley.

CHANGE IN PRODUCTION AND PRODUCTIVITY OF MAJOR CROPS

Crop	*1966-67*			*2002-03*		
	Area (000/ha)	*Production (000 tonne bales)*	*Productivity (Kg/ha)*	*Area (000/ha)*	*Production (000 tonnes/ bales)*	*Productivity (Kg/ha)*
Wheat	743	1059	1425	2250	9500	4103
Barley	182	239	1313	56	160	2883
Rapeseed Mustard	198	80	405	602	860	1488
Gram	1062	531	500	102	100	854
Paddy	192	223	1161	906	2468	2652
Pearlmillet	893	373	418	515	460	1423
Moong	39	16	410	60	30	515
Cotton	183	305	283	519	1038	195

Agricultural Research Contribution towards Increased Agricultural Productivity in economic terms.

Year	*Foodgrains production (lakh tonnes)*
1969-70	46.26
2001-2002	132.00
Increase in Production	85.74
Total cost by assuming the average cost of foodgrains @ Rs. 400/quintal	Rs. 3429 crore/annum (approx.)

(It showed that since its inception, the university's contribution through crop production only on conservative basis is manifold higher than the total expenditure on it. Thus, the technology generated by the university has led to overall improvement in the rural economy of the state).

"The impact of crop improvement technology is also well illustrated with the fact that the amount spent on research at CCSHAU (1970 to 1992) since its inception is equivalent in value to a 2% of the procurement price of wheat produced in Haryana during a single year. There cannot be any denying of the fact that the most dominating single contributory factor towards agricultural prosperity in Haryana has been the varietal input, resulting from the efforts of the plant breeders" (* Peer Review Committee Report, *1992)

- **Major cropping systems established:** Rice based cropping system covers 56% area following by cotton based, bajra based and sugarcane based systems with cropping intensity more than 172 per cent.
- The technological breakthrough in soil and water management, disease and pest management and weed control has reduced the cost of cultivation.
- **Contribution in Central Food Reserves from this state has reached to over 45 lac tons.** It was possible due to development and release of improved high yielding, disease/pest resistant and management responsive crop varieties assisted with latest production technology and

better resource management system under different agro-climatic conditions of state.

- With the development and adoption of various technologies the state of Haryana has been on the forefront of ushering in **green revolution and white revolution.** This has enabled the State to carve out a special place on the agricultural map of India and bring about all-round prosperity to the people of the state. Basmati rice produced in Haryana has ready made international markets. **The quality of basmati rice from Haryana is best among the producing states. Haryana is contributing 33% of the total export** . Growth of cotton, sugarcane, oilseeds and pulses can save a lot of foreign exchange as we are importing these products.
- As a result of intensive research on **mushroom** and its popularization through extension methodology, **Haryana state has become No. 1 state** with regard to production. This area has also opened avenues for job opportunities for unemployed youth and also marginal and landless farmers who can depend on mushroom for their subsistence. Today Haryana has 1200 mushroom growers. The commodity has also opened avenues for export potential as a consequence about a dozen export oriented units have also been established in Haryana state. At the moment production of mushroom in Haryana is around 5000 mt.tons which is likely to exceed because of growing interest among rural masses and promising entrepreneurs. Mushrooms being rich source of protein, minerals, vitamins and virtually no fats and carbohydrates promise food security and health to all, in general and diabetics and heart patients in particular.
- The bee-keeping technology developed by the university has been widely adopted in the state.
- The technology developed for the quality seed production has been adopted by the different public and private seed producing agencies. As a result of this, atleast 120 seed companies are doing business in Haryana and helping the farmers for providing quality seed.
- There was tremendous increase in the use of inputs such as fertilizers, pesticides, electricity and high yielding varieties, irrigation etc. Based on economic analysis of data on input use it is evident that inspite of new technology being inputs intensive, the increase in crop productivity has been much higher than the increase in real input costs. Hence, the cost

per unit of output has declined resulting in substantial economic gain to the farming community in particular and to the state economy in general.

- The technological breakthrough in agricultural sector due to intensive research work has created vast export potential in areas of food processing, agro-industries, horticulture, floriculture, mushroom cultivation, milk and other dairy products. Development of such technologies will not only boost our exports but will also help in reducing our imports of these and related products.
- The agricultural prosperity has given impetus to the industrialization and employment generation.

Technology for rural Women:

- Technologies like commercial production of Papad and Wadi can help an average worker to earn Rs. 11/- and Rs. 30/-per hour. The Home Science specialists have played an important role in dissemination of scientific and technological messages to women clientele related to Food and Nutrition security. These messages include safe grain storage, food processing, food utilization, food conservation, food preservation, milk and milk products, meat and related messages. These messages have high adaptability and acceptability.
- Garment construction, embroidery and hosiery technology is proving as a tool of self-employment of rural women.
- Janta Filter and vermin-composting of household degradable waste technology is being adopted, it will help in maintaining hygienic conditions as well as generating income.

Enhanced livestock productivity and better livestock health:

- The livestock sector presently accounts for approximately 1/3rd of the output of the agriculture sector as a whole with a consistent high annual growth of about 6% in the last two decades. The livestock holds the key to the prosperity and plays a major role in Haryana's economy. The poultry farming has vastly developed into an industry and deserves due notice. The milk, egg, wool and meat production have registered an approximate increase of about 2.6, 4.8, 2.7 and 2.4 times, respectively over the last two decades. This state is considered as heart land of world renowned breed of water buffalo "Murrah". On the basis of per day capita availability of milk (640 gm), Haryana ranks No. 2 (only after Punjab) in the country. The share of livestock product is estimated at

35.95% of total agricultural sector and 9.33% of GDP. Inspite of an impressive growth rate there is tremendous scope in enhancing the productivity of animal wealth in the state.

- Agriculture as practiced in India is a mixed farming type, combining food crops production with one or more livestock enterprises, like raising of cattle, buffalo, small ruminants, pigs etc. At present, the livestock is integrated with crop enterprise where cattle are primarily kept for draught. However, buffaloes are primarily maintained for milk production, and when retired, are slaughtered for meat production. About 25% of the dairy owners are landless and another 33% are marginal farmers owning less than one hectare of land. In the era of globalization of open competitive market and second generation problems of the green revolution, livestock and poultry farming has become an important component of diversification.
- The university has developed an impressive infrastructure to deal with the problems of livestock health, production and Management. The university has made incredible contributions in veterinary and animal sciences and thus significantly contributed to the rural economy and farmers' welfare. The animal health and production technologies generated by the animal husbandry scientists and transferred to the end users (farmers and field functionaries) have markedly changed the animal wealth scenario of the state.

Increased use of farm implements and SW Technology:

- The adoption of ridger seeder, mustard drill, high clearance cotton weeder, bullock drawn mutli-crop-cum-fertilizer drill, fertilizer broad caster, paddy transplanter, solar drier, feed block making machine, aonla pricking machine etc. have been very useful in minimizing the cost of cultivation in agriculture.
- Technology for subsurface drainage has been popularized which helped farmers to increase the productivity. Sprinkler irrigation technology has been popularized to make efficient use of water.

Achievement towards ecological security:

The university has taken clues from these discussions and has taken following steps in the direction of conserving eco-systems, environment and natural resources in Haryana.

- Conservation of indigenous breed and genetic resources,
- Maintenance of genetic resources of various crops, vegetable crops, horticultural crops and forest trees
- Evolved resistant crop varieties
- Integrated pest management (IPM)-with bioagents a leading component.
- Integrated weed management (IWM)
- Integrated nutrient management (INM)
- Use of biofertilizers (*Rhizobium, Azotobacter, Acetobacter, Pseudomonas and PSB)*
- Recycling of farm wastes through composting
- Use of biogas techniques and vermin-composting
- Developed techniques for safe use of brackish water
- Identified soil conserving cropping systems
- Developed integrated farming system models
- Breed improvement drive
- Popularised smokeless chullah, soakage pits, sanitary latrines, water purification, household waste disposal
- Setting up a model house in villages

Conservation of genetic resources of plants and animals

Conservation of genetic resources of plants and animals is an important fact of ecological security for posterity. The university has maintained animal resources like Murrah-Buffalo, Haryana- cattle, Beetal & Jakhrana- goat and Nali & Munjal - sheep adaptable to Haryana. These have been involved in breeding programmes to combine high production and adaptation in improvement livestock. Likewise each crop breeder maintains a few hundred to few thousand accessions to conserve gene pool including resistance sources to diseases, pests and abiotic stresses. This has enabled crop breeders to combat the expected hazards of monoculture. University has contributed over 126 elite genetic lines to National Gene Pool. A herbal garden has been established to maintain about 300 species of medicinal and aromatic plants.

Natural Resource Management

Integrated nutrient management (INM), integrated water management, integrated pest management (IPM) and integrated weed management (IWM) techniques have been helpful in creating eco-friendly and self-sustained productive environment. Significant reduction in application of nitrogenous fertilizers has been found due to green manuring which saves upto 60 kg N/ha in rice. The production of about 1.2 lacs bio-fetilizers packets of *Rhizobium and Azotobacter* per year by the university would further help in the reduced application of chemical nitrogenous fertilizers. Phospho-compost is another organic manure, technology developed by University which can be used for maintaining soil fertility without adverse effect to soil microflora. Regular detailed surveys are being conducted by the university to monitor the effect of industrial affluents on soil health around industrial cities of the state. The industries are advised to take corrective measures.

Adoption of Biocontrol methods

Successful biological control of *pyrilla* in sugarcane is one of the most outstanding achievement of this university towards maintaining friendly eco-system. Mass production techniques of *Tricogramma* and NPV have been standardized. Their bio-efficiency is being demonstrated at Farmers' field against *Helicoverpa* in cotton, gram, arhar and tomato. Aequous extracts of neem and nimoli have been effected against spotted bollworm in cotton and thrips in guava. *Thuringiensis* a bacterial bio-pesticide proved effective against diamond back moth. These steps are towards developing a eco-friendly as well as cost effective measures for crop protection. The spraying schedules of pesticides on the basis of economic threshold levels have been developed which also minimize amount of chemical/pesticides to be used. Concerted efforts have been made to develop IPM Technology for the control of insect-pests and diseases in major crops.

Release of disease resistant varieties

Development of insect/pests/disease resistant varieties of different crops like variety Asha of moong, HHB 67 of bajra, HKR 120 & HKR 126 of rice, Laxmi of mustard, WH 283 and WH 542 of wheat, HS6, HD223 &

H974 Of cotton, Varsha Uphar of okra, Hisar Lalit Of Tomato etc. has been able to minimize the use of chemical pesticides.

Organic farming and farming system

Farming system models have been developed by the University in which main emphasis has been on conservation of internal resources through recycling of farm wastes and byproducts. This helped in sustainable agricultural production with high income, more employment and enriched soil productivity under small farming situations. Recycling of organic waste by Vermiculture is another major step towards enriching ecology. University has done significant work in the field of biogas production technology that will also help in recycling the organic waste. Crop/animal based system approach is being developed.

Sand Dunes stabilization and other Production techniques

Techniques for stabilizing sand dunes by non-conventional plant species has been a success story. Techniques for water conservation and better use of ground water have been developed which are highly useful in developing a sustainable desert ecosystem. University has also been successful in developing economic soil reclamation systems, water drawing system, utilization of low grade rock phosphate as fertilizers, safe use of brackish and sodic water, eco-friendly crop rotations and cropping systems and techniques for safe and efficient use of fertilizers. All these would be highly useful steps towards developing a good ecological balance.

Use of burnt rice husk which goes as waste coupled with timely transplanting has been demonstrated to control rice blast significantly without any adverse effect on ecosystem as is normally exerted by fungicides.

Solar heat treatment of wheat seed (as an alternative of chemical treatment) has been further modified and can be practised in October for management of loose smut disease and is a step forward towards ecological security and environmental conservation.

Commercialization of Technologies:

CCS Haryana Agricultural University has entered into an agreement with National Research Development Council (NRDC) for patenting and

search of prospective buyers for the following economically viable technologies:

- Biodegradation Enzyme harvesting from buffalo/cattle cud
- Field spot test for detection of synthetic milk
- Rapid field diagnostic test for HS in cattle and buffaloes.
- A process for preparation of Anti-theileriosis vaccine
- Anti-theileriosis vaccine production technology
- Statistical Package for Mating Designs
- Machine for Pricking of Aonla Fruits for preparation of Aonla Murabba
- Design and development of a seed thresher to minimize seed injury.

DEVELOPMENT OF ANIMAL HUSBANDRY AND HEALTH

Veterinary and animal sciences are intimately related to productivity, economic development and welfare of mankind. The information on veterinary and animal husbandry practices in India or for that matter in Haryana has been derived from excavation finds, old scriptures and edicts. Initially the domestication of dog was practiced in the ancient times while art of domestication of other animals got underway in Neolithic period (3500-800 B.C.). The major achievement of this period was the development of agriculture and animal husbandry. Domestication of practically all animals on which the man is dependent till today, took place during this period. The excavations of various sites in Mohenjo-daro(Sind) and Harappa (West Punjab) have yielded several clues depicting contemporary domestic and wild animals. These sites are somewhat closer to present day Haryana and therefore the descriptions may well apply to this state. During this era called Harappan period (2300-1500 B.C.) the animals domesticated for transport and labour were elephants, ass, camel and horse. In one of the Harappan seals buffalo with long horns is shown. From the evidence it appears that the area of Punjab and Sind was the home tract of early domesticated buffalo. During Vedic period (1800-600 B.C.) the domestication of horses gave them mobility which they never had.

During the early part of epic period ,Ayurveda came into existence. Salihotra , Palakapya. Rajaputra, Nakul , Sahdev and Mrgsarma etc. probably belonged to this period i.e in the age of Mahabharata. Out of these, Nakul and Sahdev are believed to be closely related to present day Haryana as the district of Kurukshetra falls in this state. They excelled as horse and cattle doctors, respectively.

Though medieval history (1206-1761 A.D.) had several developments related to veterinary science especially during Mughal period but there are no specific references to erstwhile united Punjab which included present day Haryana. Beginning from 100 A.D there was total eclipse of veterinary science till the 18th century when the East India Company showed interest in improving the quality of horses and bullocks for military purposes.

The history of veterinary education in Haryana dates back to the year 1882 when the first veterinary school was established at Lahore in erstwhile Punjab in undivided greater India. After independence and partition of India in

1947 , with the help of faculty of Lahore Veterinary College who had migrated to India, the Punjab Government set up a camp Veterinary College at Hisar in February 1948 and was housed temporarily in the Government School. The college was affiliated to erstwhile Punjab University, Solan (now in Himachal Pradesh). The foundation stone of the present building was laid down in October 1955 and initially the departments of Anatomy, Physiology and Animal Husbandry were shifted to the new building in 1957 and subsequently the remaining departments in 1960. With the establishment of Punjab Agricultural University in 1962, Hisar Veterinary College became one of its constituent colleges. Following the establishment of Haryana Agricultural University in 1970, this college became a part of it. The College of Veterinary Sciences is now the oldest constituent college of Chaudhary Charan Singh Haryana Agricultural University, Hisar. The college offers courses leading to degrees like B.V.Sc.and A.H. , M.V.Sc. and Ph.D. The college also has a section which offers courses leading to diploma in Veterinary Livestock Development (VLDD).

The college has a Veterinary Clinic (now renamed Teaching Veterinary Clinical Service Complex or TVCSC) with excellent facilities for the treatment of livestock and pet animal diseases. The clinic provides round-the-clock service. The ambulatory service of these clinics provides clinical, surgical and gynaecological treatment to animals of some adopted adjoining villages of Hisar town. The disease investigation services are also provided throughout the state through Krishi Vigyan Kendras located at district headquarters and some other strategically important places. The college also has a modern small animal house called Disease Free Small Animal House which caters to the needs of experimental animals to various departments of the college as well as many other research institutions of the country. Considering the importance of livestock in the economy of the state and for efficient and effective undergraduate and post-graduate teaching, the college is ably supported by well equipped departments of College of Animal Sciences which came into existence in the year 1966. This college has done significant work on cross-breeding of Haryana cows with Frisian, Brown Swiss, Jersey and Red Dane exotic animals. Work is in progress on inducing lactation in sterile cows, economics of poultry, duck, turkey and Japanese quail raising and on quantitative improvements of various animal products.

In the beginning the college had 4 departments and later on in the year 1980 and 1981, two more departments were added to this college. With the merger of Animal Feed Technology department to the department of Animal Nutrition presently the number of departments has come down to five. The

objectives of the College are to develop education, research and extension programmes for the improvement of growth, reproduction and production characters of various species of farm livestock and poultry using principles of genetics & breeding, nutrition & feed technology, reproductive physiology, livestock management and processing & preservation of animal products. The College offers M.V.Sc. and Ph.D. degree programmes in 5 disciplines of Animal Sciences. At under-graduate level, the college provides supportive role in teaching of students of other constituent colleges leading to Diploma in Veterinary Livestock Development, B.V.Sc. & AH, B.Sc.(Home Sci), B.Sc. (Hons) Agri. And B.Tech. (Agri. Engg). The college has well established Animal Farms and Judging Pavilion facilities for conducting research by the faculty and for imparting practical training to students. Animal Farm of College is unique, as perhaps, nowhere else in India are so many species are being maintained at one place and that too just adjacent to the college building.

The Departments of the college attend to the queries received from prospective dairy, poultry and livestock entrepreneurs. Private cattle owners are extended facilities of artificial insemination with exotic semen. Day old chicks are supplied and custom hatching of egg is also undertaken. Services are rendered for analyzing the feed and fodder samples and computation of rations for different categories of farm livestock and poultry. Producers and distributors dealing with animal products are provided with necessary information relating to presentation, processing and marketing of these products. Preparation of feasibility reports are also undertaken to set up small scale industries and cottage industries in the field of meat, poultry and egg processing units. A number of short term courses like fifteen days' course on milk products, three months' training programme in artificial insemination and physiology of reproduction for Veterinary Assistant Surgeons and six weeks' training course in artificial insemination for Stock assistants have been regularly offered, the last two being for the benefit of nominees of the State animal Husbandry Department. The faculty members of this college are actively associated with short term training courses on Poultry farming and Dairy farming, organized by Institute of Agriculture Technology, Training and Education of the University. Apart from above, this college in collaboration with the Director of Extension Education of the University also organized the Animal Science Extension Activities for improving the livestock production in Haryana State.

The contribution of animal husbandry to the State during 1999-2000 was to the tune of Rs. 6155 crores which comes to 25% of the State GDP. Per capita milk consumption in Haryana increased from 352 gram in 1966 –1967 to 650

gram in the 2003-04. The egg production increased from 1567-lakh in 1978-1979 to 12507-lakh in 2002-03. Total meat production became triple during 1979 to 2000 from 28.79-lakh kg to 87.5-lakh kg. . Similarly wool production increased from 8.14-lakh kg in 1978-79 to 24.88 -lakh kg in 2002-03. This achievement in Livestock Sector could be attributed to increase in population of high yielding cattle and buffaloes coupled with launching of various breed improvement programmes by the University. Various animal breeding technologies for selection and multiplication of genetically superior cattle and buffaloes germplasm, adoption of improved animal management practices, expansion of infrastructure development on net work of artificial insemination and milk marketing facilities etc. have contributed significantly to increase in milk production.

The College since its inception has been successfully transferring the shape of animal husbandry and the creditable work carried out at the college on promotion of integrated programmes of genetic improvement and nutrition has helped in ushering White Revolution in the State which led the country to achieve top position in milk production. Thus the College of Animal Sciences has played a pivotal and pioneering role not only in improving the economy of farmers of the State, but it has also expanded animal production research-base in the State as well as throughout the country.

The Government of India through an act of parliament , created a body called Veterinary Council of India (VCI) which set up minimum standards of veterinary education in whole of the country. College of Veterinary Sciences, Hisar was one of the first institutions to adopt these regulations in toto . With the adoption of these minimum standards the veterinary profession in Haryana , or for that matter in whole of the country got a major fillip and long overdue separate identity.

Some of the major research achievements of this college are as follow:

1. Isolation of buffalo pox and equine herpes virus for the first time in world.
2. Production of monoclonal antibodies against buffalo immunoglogulins for the first time in world.
3. Standardization of trans thoracic approach for repair of diaphragmatic hernia.
4. Establishment and application of radiology in large animal practice for the first time in India.

5. Standardization of various fracture repair techniques in large animals.
6. Development of rapid diagnostic test for brucellosis.
7. Metabolic profiles of sheep, goat and bovine pre-implantation embryos studied and reported for the first time in India.
8. Development of monoclonal antibody based identification test ELISA for the identification of buffalo meat.
9. Development of effective vaccine against bovine tropical theileriosis.
10. Determination of etiology of post-parturient haemoglobinuria in buffaloes and evolving cost-effective therapy for it for the first time in India.

The Veterinary College faculty has the unique distinction of receiving a large number of national and international awards. Alumni of this college have excelled in all walks of life and have got several coveted positions of national and international standing.

Haryana state has the unique distinction of having several national level institutes/organizations related to veterinary science as under:

1. Central Institute for Research on Buffaloes (CIRB) at Hisar
2. National Research Centre on Equines (NRCE) at Hisar
3. National Dairy Research Institute (NDRI) at Karnal
4. Equine Breeding Stud, Hisar

The state veterinary services are efficiently run under the Haryana Government and its headquarters are at Chandigarh where the Directorate of Animal Husbandry is situated. All the district headquarters are under the charge of a Deputy Director while the civil veterinary hospitals are run by Veterinary Officers. Apart from treatment of diseased animals, the veterinary personnel also undertake preventive vaccination programmes on regular basis and also artificial insemination and castration services. The faculty of College of Veterinary Sciences and College of Animal Sciences, CCS HAU, Hisar in collaboration with the State Department of Animal Husbandry launched a big drive to vaccinate the livestock in countryside of Haryana during the worst floods of 1990. The endeavour was praised by one and all.

DEVELOPMENT OF AGRICULTURAL ENGINEERING

Agricultural Engineering education aims at training of personnel to solve the engineering related problems of agricultural and allied sectors. Agricultural Engineering is the application of engineering principles and practices to production agriculture, farm operation and drudgery removal, land and water resources development and their optimal use, efficient processing, handling and storage of agricultural produce and by-products.

The first program in Agricultural Engineering education in India was introduced in 1942 with Bachelor of Science degree at the Allahabad Agricultural Institute, Naini, Allahabad, Uttar Pradesh. The second took off in 1952 with Bachelor of Technology (B.Tech.) degree at the Indian Institute of Technology (IIT) Kharagpur, West Bengal. Indian Institute of Technology introduced Master of Technology (M.Tech) and PhD degree in agricultural engineering in 1957 and 1962, respectively. IIT provided an engineering orientation in course curriculum. The agricultural engineering education in India changed significantly with the establishment of State Agricultural Universities (SAUs) during 1960's, on the pattern of Land Grant Universities in the United States. The teaching, research and extension became integral part of the faculties. The first agricultural engineering program under this new pattern was started in 1962 at the Uttar Pradesh Agricultural University (now GB Pant University of Agriculture and Technology), Pantnagar. Presently there are 24 institutions in India offering degree programmme. In Haryana, the Northern Region Farm Machinery Training and Testing Institute, Hisar, was established in the year 1963 by the Ministry of Agriculture (Department of Agriculture and Co-operation), Govt. of India. The institute is engaged in training and testing of agricultural machinery. The Agricultural Engineering education in Haryana was introduced through the creation of Department of Agricultural Engineering at CCS HAU Hisar in the year 1970, initiating degree programme in B.Tech. (Agril Engg.) at CCS HAU Hisar in the year 1987 and diploma in Agricultural Engineering at the Polytechnique College Sirsa in the year 1988. A full fledged College of Agricultural Engineering and Technology was established in the year 1992 at CCS HAU Hisar and the departments of Soil and Water Engineering, Farm Power and Machinery and Agricultural Processing and Energy were created in the college in 1993. Presently, the college is offering undergraduate degree B.Tech.

(Agril Engg.) and postgraduate degree M.Tech. (Agril. Engg.) with specialization in Soil and Water Engineering, Farm Power and Machinery and Agricultural Processing and Food Engineering/

Specializations of Agricultural Engineering:

The model of B.Tech. (Agril Engg.) degree programme was initially borrowed from the American system. During the last five decades many changes have been incorporated in the programme to serve the changing needs of Indian agriculture and agro-industry sector. In addition to the subjects related to humanities, social sciences, basic sciences, basic engineering and agricultural sciences, the traditional subjects of agricultural engineering were farm machinery and power, soil and water conservation engineering, farm structures and rural electrification. In the course of time, additional disciplines emerged and these include agricultural process engineering, agricultural system management, dairy and food engineering, water resources development and management. At present the agricultural engineering disciplines mainly comprises of :

1. Farm machinery design and manufacture
2. Energy and power in agriculture
3. Post harvest and process engineering
4. Agricultural structures and environment control engineering
5. Irrigation and drainage engineering
6. Soil and water conservation engineering
7. Water resources development and management
8. Dairy engineering
9. Aquaculture engineering

Contribution of Agricultural Engineering:

The modern agriculture, to a great extent, depends on the level of mechanization for different farm activities such as sowing and cultivation operation, harvesting and post harvesting operations, irrigation and pumping and processing of agricultural produce. Farm gadgets such as . tractors, diesel engines. Electric motors and improved farm implements play a paramount role in increasing crop productivity. The history of farm mechanization in Haryana started with the advent of green revolution in the year 1966-67. There were only

4803 tractors in Haryana during 1966-67 which increased to 2,09,613 by the year 2001-02. Use of irrigation pump sets is another important index of farm mechanization in Haryana. There were only 25311pump sets in Haryana during 1966-67 which increased to 5,89,474 by the year 2001-02. Crop harvesting process got a boost with the use of combine harvesters in Haryana Agriculture. There were only 62 combine harvestrs in the year 1975-76 which increased to19058 by the year 2000-01. Likewise the number of crop threshers and seed drills increased from 59, 227 and 23,000 in the year 1975-76 to about 2,25,00 and 1,25,000, respectively, by the year 2000-01.

Thus, the profession of agricultural engineering has helped to meet the needs of farmers in different forms such as to mechanize their farms using more efficient tools, implements and machines, to effectively utilize available water resources and to conserve soil, to quickly and efficiently process their produce to minimize post harvest losses and for value addition.

Thrust Areas of Agricultural Engineering:

Keeping in view the changing needs of agriculture in Haryana, the several thrust areas have been identified for more emphasis in near future. The identified thrust areas include:

- Development and popularization of technology for resource conservation such as zero tillage, ridge furrow and permanent bed planting
- Mechanization of cultivation practices for vegetable crops
- Development of linkages with local farm machinery manufacturer's for adopting and up-gradation of developed technology
- Development of suitable technology for the efficient management of paddy straw
- Development of irrigation system hardware and make the innovative irrigation system such as drip and sprinkler cheaper and affordable for small farmer
- Development of irrigation water management technology for minimization of water losses, particularly for rice crops
- Practically applicable technology for groundwater recharge and conjunctive use to manage the groundwater imbalance

- Minimization of groundwater pollution from chemicals/fertilizers used in agriculture
- Development and dissemination of technology for reclamation of water logged saline lands and management of drainage effluents
- Development of small equipment for primary processing of agricultural produce
- Process development for dehydration of fruits and vegetables
- Utilization of crop wastes to produce useful by-products
- Development of appropriate technology to reduce post-harvest cost and
- Development of technology for telecommunication, telemetry and automation in farm irrigation systems such as drip and sprinkler irrigation system.

Agricultural engineering has been accepted as one of the major disciplines contributing to increased productivity of agriculture in the country by way of increasing efficiency of inputs, conservation of resources and reducing post-harvest losses besides value addition of agro-produce. To further increase the scope of agricultural engineering additional specialized training would be necessary in areas like minor and precision irrigation, remote sensing and geographical information system, watershed management, post harvest technology, aquaculture, food engineering, value addition of farm produce, agro-waste utilization and energy management in agriculture.

DEVELOPMENT OF HOME SCIENCE EDUCATION AND RESEARCH

Home Science, a field of knowledge and service concerned primarily with improvement in quality of family life, in India was conceived as a nebulous idea about a century ago. It was only in 1950 that this important subject was upgraded to University Level and was given an academic framework. The purpose of the home science education is the creation of an environment and an outlook which enable families/households to live richer and more purposeful lives. It provides opportunities to the students to acquire knowledge and skills, and empowers them for effective role-performance to meet the challenges of technological advancement by developing fundamental skills and making them job provider rather than job seeker.

Beginning of Home Science Education in India

Home making has long been an art for women in India. Duties of the home and the art of home making were handed down by the mother to the daughters. It was not thought necessary that this art required any teaching outside the home, as young girls to be good housewives and mothers imbibed this traditional skill from their elders. In fact, in earlier times, teaching of home science in an institution was considered wastage of public funds. Drastic changes in the position of women occurred in early years of the 20^{th} century when in India the education for women became equally important. Initially, some arts and crafts work such as needle work, painting, embroidery, music etc. were introduced in the curriculum of elementary schools. This represented the beginning of home science in India which was then called 'Domestic Science'. The spread of home science education started when Maharaja Sayaiji Rao Gaekwad of Baroda, (Gujarat) opened Maharani Girls High School at Baroda in 1917 with Miss Nidham, a graduate from Cambridge, USA, as its founder principal. During the same period Dr. Karve, who worked for the cause of women's emancipation, opened the first and only Indian women's university in 1916, which was later, renamed as SNDT University. A special curriculum was evolved and a set of subjects was offered in regional languages. But the idea did not work out due to lack of trained staff.

In 1927, All India Women's Association made a resolution to advance women's education in India and expressed the need for including a comprehensive type of education related to the home, for girls. Thus, the idea of home science as a subject of study was born. In 1932, this association opened Lady Irwin College at Delhi to promote home science discipline, which offered a 'Diploma in Home Science'. In 1935, the Agriculture Institute of Allahabad started a Diploma course in home science and it became the university level department in 1945. Women Christian College, Madras and Queen Mary College, Madras were the first to introduce the B.Sc. course in home science in 1942.

In 1950, first faculty of home science was established in Baroda with twin objectives (i) to prepare good home makers (ii) to prepare professional home scientists. M.Sc. – A Master's level programme at Baroda was started in 1956. Lady Irwin college got affiliated to the University of Delhi and started offering B.Sc. degree course in home science in 1950 and M. Sc. degree in 1958. The first conference of home science teachers was organized at University of Baroda in 1951 and in the year 1952, Home Science Association of India was born.

Home Science in Agricultural Universities

Establishment of agricultural university in each of the states of India (SAUs) was an important landmark in the history of home science. Home being an important unit of production and consumption in an agrarian country like India, the need of home science education was recognized. The first home science college under SAUs was started at PAU, Ludhiana (Punjab) in 1966. At present, there are 33 agricultural universities in India and the most havie a home science college to cater to the needs of rural families.

Home Science education in CCS Haryana Agricultural University (HAU)

In the year 1970, when HAU was founded, there were about 16-lakh of females between the age group of 15-50 years, in the state. Out of this, 5-lakh female were from rural areas in the age group of 15-25 years. For education of this age group there was not even a single college with Home Science subjects. Under such circumstances, the need for College of Home Science in HAU was envisaged. Home Science college is an integral part of any Agricultural University but Mr. Fletcher, the then Vice-Chancellor, wanted the college of Home Science at HAU to be an institution with a difference. His vision was that for times to come, this college at HAU should stand out as an example of the temple of learning for rural girls to higher education.

For the attainment of this goal, Dr.(Mrs.) Durga Deulkar, Director of Lady Irwin College, New Delhi and Dr. Lois Lund, Director of School of Home Economics, Ohio State University, USA, were appointed as Technical Advisors of the Home Science Education. A Committee, consisting of Dr. Durga Deulkar as the Chairperson and Dr. S. Roy, Mrs. B. Menon, Mrs. R. Despande, Mrs. T. Jacob (Faculty members of Lady Irwin College) and Ms. S. Doongaji, Principal, Home Science College, Chandigarh, as members, was formulated to work out the details for the establishment of the College. Mr. A. L. Fletcher, Vice-Chancellor; Mr. I.D. Mirchandani, Chief Engineer; Sh. Rajinder Pal Singh, Architect (from HAU); Shri J.K. Chowdhary, Architect, Planner and Consultant of M/S. Chowdhary and Gulzar Singh, New Delhi and Mr. James Miller, Advisor Campus Development, USAID were also associated with Deulkar Committee. This Committee contributed significantly to the development of objectives, philosophy, course content, requirement of laboratories, class-rooms, equipment, other infrastructure, and staffing pattern of the proposed College with reference to various programmes to be implemented.

In October, 1972, First Home Science faculty member, Mrs. Achla Malaviya joined as Assistant Professor and was assigned the duty to have liaison between the Vice-Chancellor, HAU and Dr.(Ms.) Durga Deulkar, chairperson, Deulkar committee for smooth functioning of the institution. In January 1973, Mrs. Uma Verma and Mrs. Indu Grover joined as Lecturers in Home Science.

Keeping in view the recommendations of Deulkar Committee, Indira Chakravarty College of Home Science, named after the then First-Lady-of-the State, was established on Ist August, 1973 with the following objectives:

i) To develop knowledge, skills and competence in the application of science in daily living.
ii) To create an understanding of the needs, problems and solutions to family and community living.
iii) To increase abilities and skills to achieve a better standard of living.

Keeping pace with the technological advancements, present day needs, and future challenges in the competitive society, the home science curriculum has

been revised from time to time. Presently, the Home Science curriculum has two broad objectives:

1) To develop abilities for effective resource management and improved quality of life.

2) To prepare the girl students for multiple role performance by providing and enhancing entrepreneurial skills.

Academic Programmes

B.Sc. Home Science

In the beginning only under-graduate programme was started under two streams: Three year programme after higher secondary and four year programme after High School. The response to these programmes was overwhelming.

Now the college offers(1998-99 onwards) a four year B.Sc. (Hons.) Home Science degree programme. This programme has a unique feature of providing professional education in the final year of its program through various Professional (Elective) courses. The students can choose any one of the professional courses out of the following:

- Apparel Designing
- Institutional House Keeping
- Bakery & Confectionary
- Pre-school Management
- Journalism and Mass Communication

All these courses are followed by eight weeks **In-plant training** in the related industry/organization. For taking home science education and technology to the doorsteps of the women in rural areas, the students also undergo 12 weeks of **Rural Home Work Experience (RHWE)** during which they adopt the rural families and interact very closely with them.

Post-Graduate Programmes

The college offers M.Sc. and Ph.D. programmes in all the five disciplines of Home Science, viz. – Clothing and Textiles, Family Resource Management, Foods and Nutrition, Human Development and Family Studies, and Home Science Extension Education.

Professional Courses	**Duration**	**Seats**
PG Diploma		
• Apparel Designing & Management	- 1 year	20
• Human Nutrition and Dietetics	- 1 year	20
• School Counseling	- 1 year	20

Certificate Courses	***Duration***	***Students***	***Department***
• Home Industry Garment Construction & Hosiery	- 1 year	30	Clothing & Textile
• Bakery & Confectionery	- 4 months	20	Foods &Nutrition
• Creative Arts Management	- 4 months	20	Family Resource
• Apprentice Workshop Textile	- 1 year	10	Clothing &

One year certificate course in Home Industry Garment Construction and Hosiery is for needy rural women of low economic strata of population. The top ten students who complete one year certificate course are admitted to Apprentice Workshop. This course aimed at developing skill in garment construction and Hosiery for household and commercial production. During this period they earn money by stitching and knitting.

Staff position and department

The College was initially started with only five faculty members and there were no separate departments. After three decades of its existence, the College has attained a prestigious position and is considered one of the best Home Science College'in the country.Today the college has five departments viz; Foods and Nutrition, Clothing and Textiles, Family Resource Management, Human Development and Family Studies, and Home Science Extension Education and 35 staff members in teaching and 7 in research. Most of the faculty members are Ph.D and have international exposure besides having a vast experience in teaching and research. The faculty members do participate actively in national and international seminars/conferences/trainings/summer and winter school etc.

for updating and enhancing their professional competence. The Home Science Technologies developed at the College are transferred to rural women, by 16 home science specialists posted at Krishi Vigyan Kendras (KVKs) at the district level.

Gold Medals and Scholarships

To encourage a healthy competition among the students, the college awards 4 **Gold Medals** every year:

- HAU Merit Gold Medal
- A.L. Flecher Gold Medal
- Chander Kanta Lamba Gold Medal
- International Women Year Gold Medal

Scholarships:

- HAU merit Scholarship
- Merit-cum-means Scholarship
- Financial assistance to SC & BC students
- Stipend to all PG students

The College has modern facilities for carrying out the various activities. It has well equipped laboratories, lecture halls, library and well furnished auditorium and computer laboratory. There are excellent hostel facilities for students. Department of Human Development and Family Studies (HDFS) provides day-care services to young children below 5 years for the benefit of working mothers. It also trains students in enhancing their competency in management of pre-school programmes.

Besides an excellent academic environment, the students of the College of Home Science also have good opportunities for their all-round development. The students have facilities for dramatics, debates, graphic-arts, hobbies, mountaineering etc.

Research

The college has made excellent strides in research. Up to now thirty projects have been completed and twenty seven projects are running in the college. Research is mainly focussed on the following areas:

1. Environment and sanitation
2. Drudgery reduction in carrying heavy loads of fodder and fuel on head and other household and agricultural activities.
3. Women dairy cooperatives.
4. Energy conservation and use of non-conventional energy, sources for domestic use.
5. Enhancing women's income, thereby improving the quality of life.
6. To improve nutritional status of women and children in rural areas.
7. Low cost recipes using locally available foodstuffs to overcome malnutrition
8. Malnutrition status of vulnerable sections
9. Micronutrient deficiencies prevalent among rural population
10. Income generation through stitching related and other activities
11. Developmental studies among children of different age groups
12. Empowerment of adolescent girls
13. Maternal and child mortality and morbidity and remedial measures.

Major achievements in research:

Foods & Nutrition

- Value added products have been developed using pearl millet, soybean, potato, tomato, til, groundnuts, pumpkin.

- Iron rich recipes have been developed using green leafly vegetables for combating iron deficiency anaemia.

- Nutritional status assessment has been done for pregnant women, adolescent girls, pre-school children in different districts of rural Haryana.

- Low cost weaving and nutritious supplementary foods have been developed for improving nutritional status of infants and young children.

Clothing & Textile

- Standardized anthropometric measurements and bodices block for children aged 1-10 years.

- Standardized anthropometric measurements of women and developed paper patterns for lady's kameez for various bust size (32", 34", 36" & 38") and girls tops (32")

- Developed functional garments for the physically challenged males and females having different types of disabilities.

- Standardised dyeing and printing conditions for wool, cotton and silk and developed various shades of brown, peach, yellow, orange and green using locally available vegetable sources.

Family Resource Management

- Cot bag was developed which reduced the drudgery of women upto 50% and increased the output by 20% during cotton picking.

- Improved sickles were tested and falcon wooden sickle was found to be the best as it reduced the drudgery by 23% in fodder cutting and wheat harvesting over the existing sickle.

- Capron was developed and found to be highly acceptable by women during wheat threshing which could protect the women from pollution.

- MDV wood stove was developed with thermal efficiency of 20%.The fuel consumption was reduced by 27% with less generation of smoke over the traditional wood stove.

Human Development and Family Studies

- Developed norms on rural children of Haryana (0-6 years) for height, weight, chest circumference, head circumference and arm circumference.

- Developed assessment tools for cognition, social cognition, spatial cognition and meta-cognition.

- Developed intervention packages to promote overall development of the child.

- Developed appropriate curriculum for preschoolers.

Home Science Extension Education

- Skilled trainings, educational camps/campaigns/meals/field days have been organised by department under different schemes and through students practicals in more than 100 villages on improved home-farm and dairy practices through community participatory Rural Appraisal (PRA) and social marketing.

- The concept of Self Help Groups (SHGs) has been made viable by organising farm women in groups with the philosophy of togetherness. They have been enticed into the habit of saving.

- Through SHGs, a number of micro enterprises have been initiated in Hisar district: (Rawalwas), Atta Chaki, (Umra), Papad and Wadi (Kirtan), Surf making (Balsamad), Khoya and Gajerpak making (Kirtan) Masala grinding (Chenat – under process). Eighty seven units of vermi composting are operating in 8 villages of Hisar and Fatehbad district namely Balsamand, Kirtan, Rawalwas, Umra, Sultanpur, Chenet, Chindar and Dharnia.

- A sample comprising of three thousands rural women belonging to 20 villages of eastern & western zones of Haryana was researched

and analysed in terms of participation, decision making, time use pattern in home farm and livestock activities.

- Indigenous knowledge has been identified in various areas like maternal care, storage of wheat, storage of food commodities, dairy herd management and medicinal plants for health security. Herbal garden have been established in fifteen families of adopted villages.. Media package in the form of electronic and print media was prepared on scientific storage of wheat.

- The technology of MDV smokeless chulha & pearl millet ladoos are in the process of standardization in Dhana Kalan, Dahima villages of Hisar district.

The college which was established in 1973, has over the years grown remarkably and attained recognition as one of the best colleges in Home Science in India. The graduates of the College have found access to various Colleges and Universities and state departments as teachers/scientists, Project Officers, Child Development Project Officers within the country and beyond besides working in print and electronic media in fashion industry, tourism department and Hospitals.