

Brief-Bio-data

- 1. Name:** : DR. SHYAM NARAYAN JHA
Date of Birth : 02/04/1964
- 2. Current Position and Address** : Assistant Director General (Process Engineering),
 Room No: 407, Krishi Anusandhan Bhawan – II,
 Indian Council of Agricultural Research, New Delhi
 E-mail: snjha_ciphet@yahoo.co.in, Mobile: 9417601715
 Website: www.snjha.in



3. Educational Qualification

Sl. No.	Degree/ Certificate	Year of Passing	University/ Institute	Subjects
1.	B. Tech.	1987	RAU, Pusa, Bihar	Agricultural Engineering
2.	M.Tech.	1990	IIT Kharagpur	Postharvest Engineering & Technology
3.	Ph.D.	1995	IIT Kharagpur	Agricultural & Food Engineering
4.	JSPS Postdoctoral	2000-02	Kochi University, Japan	Post-harvest Technology/ Nondestructive evaluation of Food Quality

4. Academic/Research/Experience/Employment

Sl. No.	From	To	Organizations	Scale of Pay, Rs.	Position held
i.	30/12/2015	Till date	ICAR, HQ, New Delhi	37400 -67000/- RGP 10000/-	ADG (Process Engineering)
ii.	06/05/2015	29/12/2015	ICAR-CIPHET Ludhiana	37400-67000/- RGP Rs.10000/-	Project Coordinator, AICRP on PHET
iii.	16/05/2013	13/02/2014	ICAR-CIPHET Ludhiana	37400 – 67000/- RGP 10000/-	Director (Acting)
iv.	17/02/2010	16/02/2015	ICAR-CIPHET Ludhiana	37400-67000/- RGP Rs. 10000/-	Head, AS&EC Division
v.	26/11/2007	Till date	ICAR-CIPHET Ludhiana	37400 – 67000/- RGP 10000/-	Principal Scientist
vi.	26/11/1999	25/11/2007	ICAR-CIPHET Ludhiana	12000 – 18300/- (unrevised)	Sr. Scientist
vii.	28/07/1998	25/11/1999	ICAR-NDRI Karnal	10000 – 15000/- (unrevised)	Scientist (SS)
viii.	30/10/1994	27/07/1998	ICAR-NDRI Karnal	8000-13500/- (unrevised)	Scientist
ix.	10/11/1993	29/10/1994	ICAR-NAARM Hyd and CIAE Bhopal	8000– 3500/- (unrevised)	Scientist (Trainee)
x.	30/07/1991	09/11/1993	RAU Pusa Bihar	2200-4000/- (unrevised)	SMS/ Jr. Scientist
xi.	30/12/1989	31/05/1990	IIT Kharagpur	700-1600 (unrevised)	Jr. Research Officer

- 5. Area of Specialization** : Post-harvest/Food Engineering & Technology

6. (a) Training/EDP/MDP attended

Title of the Training	Name of Institution	Duration of Training
Developing Effective organizational leadership	ASCI Hyderabad & different institutions in Netherlands, Germany, Belgium, Switzerland	02 – 04 August 2019
		21 – 30 Sept 2019
Workshop training on Priority setting, monitoring and evaluation	NIRD Hyderabad	16-20 June 2008
MDP on public private partnership for innovation in Agriculture	IIM Lucknow	20-24 July 2009
MDP on Leadership development	NAARM Hyderabad	26 August–6 Sept 2013
EDP on Leadership development	NAARM Hyderabad	27-31 August 2016

(b) Teaching/HRD/Capacity building programme involved as Teacher/course Director

Name of the program organized	Organizations	Year	Duration
Taught many UG, PG and PhD courses	NDRI Karnal	1994-99	5 years
Programme Incharge of IGNOU one year Diploma course	IGNOU New Delhi	2006-07	2 sessions
Summer School on Design of storage structures and quality assessment techniques for agricultural produce	ICAR sponsored Co-coursedirector	2003	21 days
Winter School on Nondestructive and biosensing methods for food safety and quality assurance	ICAR Sponsored Course Director	2007	21 days
National Training on “Rapid and nondestructive evaluation of food quality and safety factors using spectroscopy and biosensing methods”	ICAR-NAIP sponsored Course Director	2011	14 days

(c) Dissertations Supervised

- a. Post-doctoral : one overseas scientist
- b. Post-graduation: 4 (co-supervisor)

7. Honors/Awards/Recognition

According to Stanford University USA study for year 2019 and life time citations Dr. S. N. Jha is listed amongst the top 2 % scientists across all disciplines of research in the world.

(A) Fellowships/Recognition/Awards

I. Fellowships of

- i) National Academy of Agricultural Sciences (NAAS) India
- ii) National Academy of Dairy Science India
- iii) Indian Society of Agricultural Engineers (ISAE)
- iv) Institution of Engineers India
- v) Japan Society for Promotion of Science (JSPS) Japan

II. Awards/recognitions

- i) The first best Alumni Award 2020 of CAE-DrRPCAU Pusa, Bihar
- ii) Best Research Paper Award 2019 of Journal of Agricultural Engineering
- iii) **Gold medal 2018** of Indian Society of Agricultural Engineers for Outstanding contributions to science and Society (Life time achievements award)

- iv) Best Research Paper of 2016 published in Journal of Agricultural Engineering
- v) **ICAR Chaudhary Devi Lal Outstanding All India Coordinated Research Project (AICRP) Award 2015** as Project Coordinator of AICRP on Post-harvest Engineering & Technology
- vi) **Societal Innovation Prize of NRDC, Govt. of India** - 2013
- vii) **ISAE Team Research Award (as Leader of Team)** - 2012
- viii) **Recognition Award** 2011-12 of National Academy of Agricultural Sciences
- ix) **Best Poster paper** Award 2012 in 46th ISAE Annual convention and International symposium
- x) **ICAR Rafi Ahmed Kidwai Award** 2011 for outstanding research in Natural Resource Management & Agricultural Engineering. **It is highest individual award of ICAR**
- xi) **ISAE Commendation Medal** - 2007-08 for outstanding contribution in Food Processing
- xii) **Dr. J.C. Anand Gold Medal-2006** of Horticulture Society of India
- xiii) **First Best Scientist of the CIPHET Award** in 2005
- xiv) **Young Scientist Award** for the year 1997 of AFST (I), CFTRI Mysore
- xv) **Second Best Poster Paper Award** in International Food Conference -1993, CFTRI Mysuru
- xvi) **Reddy Award - 1989-90** of ISAE for outstanding postgraduate thesis.
- xvii) **National Merit Scholarship**, till B Tech degree

8. Professional Affiliations

- (i) Fellow of National Academy of agricultural Sciences, India
- (ii) Fellow of Institution of Engineers (India)
- (iii) Fellow of Indian Society of Agricultural Engineers
- (iv) Fellow of National Academy of Dairy Sciences India
- (v) Life member of Dairy Technologies Society of India
- (vi) Life member of Indian Dairy Engineers Association
- (vii) Life Member of Association of Food Scientists and Technologists (India)
- (viii) **Editor** (Processing, Dairy and Food Engineering) (since 2012) of Journal of Agricultural Engineering of ISAE since 2012
- (ix) Associate **Editor** (since 2017) of Journal of Institution of Engineers (Series A) published by **Springer**

9. (a) Publications including popular articles/books/book chapters/ conference

proceedings/training manuals etc: >270 Total citations >3500, **h-index 35** i-10 index 66

- (b) **Number of books Authored/edited**:: 05 (One each from Springer and Elsevier)
- (c) **No of patents granted** : 4
No of patents filed : **5 (including on International in PCT countries)**
- (d) **NCBI Registrations of microbes/** : 82
MTCC depositions of culture

10. List of best professional outputs/outcomes relevant to field of specialization

- (i) Formulation of colour based maturity index and eating quality of mango and method to predict them nondestructively (**BIS standard IS 9304 revised in 2012, patent grant no: 250880, Licensed to M/S Neotel Systems and Services Pvt Ltd, Chandigarh.** Considered pioneer for research on nondestructive methods for quality evaluation of food in India (**ICAR Citation: Rafi Ahmed Kidwai Award 2011**).

- (ii) Developed physico-chemical properties based maturity indices for nine mango cultivars and method of predicting them along with eating quality using NIR spectroscopy (**patent no 309470, besides development of FTIR technique to authenticate sweetness of mango juice (Jha and Gunasekaran 2010)**), identification and behavioural study of properties and their modeling for computing freshness index (**Jha & Matsuoka 2002**) of eggplant fruits, overall quality index of apple (**Jha et al 2012**), and roasting behaviour of gorgon nut (*Euryale ferox*) (**Jha 2005**).
- (iii) Development of CIPHET Evaporative Cooled Storage Structure with maximum possible cooling efficiency (up to 20 °C drop from outside temperature, **licensed to 5 agencies** and given drawing and designs to more than **20 farmers/entrepreneurs**) for storage of fruits and vegetables (**Jha S. N. 2008**). **Recently Govt of Odisha, Chhatisgarh and Bihar have included it in their NHM programme.** In addition developed containers for horticulture train in sponsorship of NHB for distant transport of fruits/vegetables.
- (iv) Development of process technologies & machinery for popping and decortication of *makhana* (**patent application no. 674/DEL/2013**) **licensed to M/S Jwala Engineering and Consultancy Services, Ambala** for commercialization). The Govt of Bihar has started giving 50 % subsidy on this machine. **This has won NRDC Societal Innovation Award 2013.**
- (v) Development of ready to constitute *makhana kheer* mix (**Licensed for commercialization on royalty basis to M/S Vijay Raj and Company, Darbhanga, Bihar, M/s Ultra Bio Naturals, Baddi, Himachal Pradesh and M/s AI Foods India Pvt Ltd, RR District Telangana** and at least two companies are in pipe line for licensing, **Patent grant no 287541**). Pioneering the research in post-harvest processing of *makhana* (**ICAR Citation: Rafi Ahmed Kidwai Award 2011 and Citation of NAAS Recognition Award 2012**).

11. Technologies developed, licensed and/or commercialized with details

(i)	CIPHET Evaporatively Cooled Storage Structure for fruits and Vegetables	It is ideally designed 5 tonne storage structure based on water evaporation. It is most suitable for storage of fruits and vegetables in hot and dry region. Adopted by farmers, government and private agencies. It is also included in NHB pack house project.
(ii)	Tomato primary processing and puree making plants	Licensed to two entrepreneurs Mr. Ushir Shantosh Murlidhar, Maharashtra and Mr. Amaranatha Reddy of Madanapally, AP. Machinery designed are being sold by M/S Osaw Agro Industries, Pvt. Ltd., Ambala without license since 2003
(iii)	Ventilated and insulated freight containers for fruits & vegetables	Designed, tested in collaboration of CONCOR, TRANSFAE and NHB for long distance transport of fresh fruits and vegetables through road and rail. National Horticulture Board, Gudgawn Govt. of India tested and commercialized the technology. Latter Rail transport system was named as Horticulture Train. Performance of the system was excellent. Govt. of India started Kisan Train on the concept and is running very successfully
	Method of determining maturity of mango in tree	It computes maturity of mango based on TSS and colour . Patent grant number 250880 . Technology is licensed to M/S Neotel Systems and Services Pvt Ltd, Chandigarh and formulae has also been adopted in BIS standard IS 9304: 1979 revised in 2012 (Guide for harvest and storage of mango).
(iv)	Mechanized system for popping and decortication of <i>makhana</i> seeds (Gorgon nut, <i>Euryale</i>)	This is the first machine for popping and decortication of <i>makhana</i> seeds (capacity 30 kg/h efficiency 95 %) raw seeds. It has been licensed twice to M/S Jwala Engineering and Consultancy Services; Ambala and two more one in MP and other in HP. It almost eliminates all the drudgery involved in manual method and also improves the quality of popped <i>makhana</i> . Simply decortication of

	<i>ferox</i>)	seeds can also be done which was hitherto not possible. About 10 plants have come up on this in different part of India. It has won NRDC Societal Innovation Award. Patent no 674/DEL/2013
(v)	Method of predicting maturity stage and eating quality of Indian mangoes using near Infrared spectroscopy	A single maturity index of 8 major varieties of mango was developed using various bio-chemical properties; and a NIR prediction model with protocol predicts ripeness level and eating quality nondestructively. It has opened new vistas of research and many projects/works now are being carried out in this field. Patent no 309470. Handheld instrument based on this is being manufactured by a Bengaluru based company.
(vi)	Ready to Constitute <i>Makhana Kheer</i> mix	<i>Makhana kheer</i> can be prepared instantly and without cooking. It is the First product patent of ICAR. Patent Grant no 287541. Technology has been licensed to M/S Vijay Raj and Company Darbhanga Bihar, M/s Ultra Bio Naturals, Baddi, Himachal Pradesh, A1 Foods India Pvt Ltd, Telangana and two more companies/startups. The product is highly acceptable, profitable and is having high export potential.
(vii)	Autoclavable microencapsulation system	It is an autoclavable microencapsulator having multi stage jet break up system using two fluid nozzle for clean production of microcapsules. Licensed to M/S Singh Glass Work, Ludhiana and is being sold in laboratories, institutions for R & D purposes. Patent No.324943.
(viii)	Method of manufacturing porous bricks	The process uses paddy straw, wheat straw and earth as major ingredient for manufacturing porous brick, which is about having one third less weight than the traditional brick with strength equivalent to Class II brick. It is very good for partitioning wall, having high insulation properties. Good for making Evaporative Cooled Storage Structure. Patent Application no. 1883/DEL/ 2008 and is Licensed to M/S Rajinder Dev & Company, Ludhiana for manufacturing and marketing.
(ix)	A mechanized system for continuous production of <i>chhana</i> ball for making <i>rassogolla</i>	The system developed produces about 46 <i>chhana</i> ball of homogeneous and uniform size and weight of 6 g per minute. It helped in mechanization of <i>rassogola</i> and <i>gulabjamun</i> production in the country. Technology is Licensed to AMUL, Anand and is commercialized.
(x)	Value Chain/ Agro-processing centres	(i) Value Chain on <i>makhana</i> popping is comprising, cleaning, drying, grading, roasting and popping, grading of popped <i>makhana</i> and value added products like, bran, ready to constitute <i>makhana kheer</i> mix were developed; and first part has been established at about 10 places in India. (ii) Value Chain for primary processing and manufacturing of tomato puree and the same is being manufactured and sold by Osaw Agro Industries Pvt Ltd. Ambala. (iii) Twenty Agro-processing centres as project Coordinator and about 31 as ADG (PE) established throughout country in farmers' field and they are running successfully with greater profits.

12 Highlights of major contributions

(a) **Major contributions to the area of specialization** are: development and commercialization of process and machinery for popping of *makhana* (*Euryale ferox*) and their value added product ready to constitute *makhana kheer* mix, mechanized system for manufacturing *chhana* ball for continuous manufacture of *rassogolla* being used by AMUL, nondestructive techniques to know ripeness; eating quality of mangoes; freshness index of eggplant and correlation of the same with market price after storage, and overall quality index

of apple. Enrichment of literature by giving new mathematical concepts of roasting of grains, modeling of colour values of mango, and extraction of juice from citrus fruits. A community level evaporatively cooled storage structure design is much in demand. Development of a porous brick using biomaterials for construction of storage structures and farmhouses is an important contribution for utilization of farm residues.

More than 260 research papers/book chapters/conference presentations/ patents and five books are highly cited in literature. **Total citations are more than 3500 with *h-index* 35 and *i10 index* of 66 on Google Scholar as on 31/04/2021.**

Major areas of professional interests are nondestructive methods of quality evaluation of food, development of new products/process and machinery and design and development of storage structures for fruits and vegetables and guiding/working on new ideas of future needs. Both all India Coordinated Research Projects (AICRP) on Post-harvest Engineering and Technology and Plasticulture Engineering and Technology, under my leadership as Coordinator and Director of ICAR-CIPHET received the best AICRP awards of ICAR.

Present activities are planning, monitoring, policy support and management of research in the field of Post-harvest Engineering and Technology and to give leadership to various research projects and consultancy works in the field of agro-processing and value addition at National Level.

(b) Highlights of contributions as Institution Leader/ R & D manager

As Head of division five new laboratories established, three new fields of research (nondestructive evaluation of food quality, microencapsulation, and smart packaging) started, more than 10 crores research funds attracted and arranged overseas visits of 6 scientists. Division, on an average, produced more than two research papers and one patent per year per scientist, besides commercialization of majority of them. Probably first time a laboratory of division of ICAR institution got **ISO certification. QRT of that period of ICAR-CIPHET Ludhiana judged the best division of the Institute.**

As Project Coordinator of AICRP on PHET for about 1.6 years (including acting period of about one year) started 17 new value chain projects and established more than 50 agro-processing centres through AICRP's centres in different parts of country. Harvest and post-harvest loss assessment of major crops and commodities at national level were determined and the same is being used for policy making by governmental and non-governmental institutions/organizations. Culture of publications, patents and commercialization introduced and result was that this AICRP **won The ICAR Chaudhary Devlal Outstanding AICRP Award for the first time in 2015.**

As Director of ICAR-CIPHET Ludhiana for about nine months the whole Institute received ISO 9001:2008 certification. Conducted Parliamentary Committee Meeting on Hindi and received the appreciation letter for the way meeting was organized under my leadership. Conducted record 22 DPC for CIPHET staff in 9 months. Organized IMC, RAC, IRC, IJSC (3 no), monthly SOC etc and utilized all the budget provision of the Institute including NAIP in record time by 31st December 2013 itself and achieved 117 % of target of revenue generation of Rs. 40.90 lakh by the institute. Regularized payment of all contractual pending since many years, and made the institute (including Abohar Campus) trouble free, other-wise it was always with labourers problems. Won four court cases in record time in favour of ICAR and Improved work culture, sincerity and punctuality in all staff (at least in 90 % staff).

Efforts were put to increase scientific manpower and got 39 Engineering Scientists' post advertised in ARS 2013 and 8 scientists posted and one got transferred to CIPHET Ludhiana.

In addition about 100 internal/CAG audit para (particularly of NAIP projects) coming since three-four years got dropped by making suitable reply. On Infrastructure development front, International Training Centre, state-of-art BPD Unit, On-line ASRB examination centre, conversion of Abohar campus KVK building to guesthouse, Food Testing Laboratory, Wi-Fi facilities in whole campus (including residential area) got completed and backlog works having time-overrun and cost-overrun since 2006 got regularized by the council. Modernized two laboratories and about 10 new constructions were conceived and got approved in the 12th five year plan. More than 50 % staff got training, PDF scheme with international organization initiated and MoUs were signed at least with three universities during the period. **AICRP on Plastics Engineering and Technology received ICAR Chaudhary Devlal Outstanding AICRP Award and institute's RFD reached from near good (when took charges) to the excellent level (when handed over the charges).**

As ADG (process engineering) at ICAR headquarter following are major contributions in policy making/programme implementation at National level.

Prepared and got two Plan SFC Titled “Post-production mechanization and value addition” and “Fibre processing and value addition” for 2017-20. Monitoring and management of ICAR’s engineering and two AICRPs (PHET, PET) and 3 CRPs on Health food, secondary agriculture and natural fibre. Budget of Engineering SMD got increased by about 75 % for these schemes in 2018-19.

I was directly involved in policy change in engineering aspects of ICAR and got merging of two ARS disciplines (APE & ASEM to one AS&PE), approved two new ARS disciplines, i.e. Electronics & Instrumentation Engineering and Textile manufacturing and technology and cadre review of scientific, technical and administrative staff of all ICAR Engineering Institutes. I was instrumental in delegation of power for purchase of approved laptop/tablets to Director of ICAR Institutes and change of name and mandate of NIRJFT Kolkata to National Institute of Natural Fibre Engineering and Technology(NINFET), Kolkata. Involved directly in Loss assessment in FCI and CWC godowns and framing national policy for the same to store and release of wheat and rice; and framing of storage protocols, milling outturn etc for pulses under ministry of consumers affairs is in progress under my guidance and supervision. With lot of persuasions and providing inputs Process Engineering posts in all KVKs are made compulsory, Post-harvest/processing aspects and establishment of Post-harvest equipment testing centres are added for funding in RKVY schemes of Govt. of India, Establishment of Food Testing laboratories, Pradhan Mantri Sampada Yojana, Gramin Samridhi Yojana of MoFPI, Govt of India were made using my input and majority of them are in operation at National level.

13. Worked as Chairman/member of various National committees/organizations

- (i) Chairman Technical manpower promotion committee of ICAR-CAZRI Jodhpur
- (ii) Chairman FAD 16 committee of BIS, GOI
- (iii) Chairman of ICAR/ISAE Award committees
- (iv) Chairman of various technical sessions of National/International seminars/conferences
- (v) Chairman evaluation committee for Niche area of research funded by ICAR to IARI New Delhi
- (vi) Nodal officer of ICAR for office of Principal Scientific Advisor to Govt. of India
- (vii) Chairman of DPC for promotion of ICAR-NRC Pomegranate scientist
- (viii) Member APEDA Governing Council

- (ix) Member of Inter-ministerial Technical Committee & Monitoring committee of Food Processing level and Post-harvest Loss determinations by MoFPI
- (x) Member of Codex committee of FSSAI
- (xi) Member, National Committee on Plastic Applications in Horticulture, GoI
- (xii) Member of Scientific panel of FSSAI, GoI
- (xiii) Member, Executive Council of DBSSKKV Dapoli
- (xiv) Member of Expert panel of Judges for selection of different Awards of Odisha Bigyan Academy
- (xv) Member of ICAR Indian Grain Storage Working group
- (xvi) Member of expert committee for interviews and different DPCs by ASRB
- (xvii) Member – Secretary of CIPHET RAC and member of Institute management committee of three ICAR institutes
- (xviii) Member Sectional (section VII) Committee of NAAS, India
- (xix) Member Executive Council of NASS, India
- (xx) Member NAAS Journal Scoring Committee (two terms)

13. Summary of vision as Leader in Agricultural field

India's agricultural production is at all time high and is almost in increasing order, but according to latest ICAR study post-harvest losses of 45 major crops are of more than Rs. 92 thousand crore. People therefore have started talking, **“whether we produce more for losing more?”** Importance and attention as this field needs have not been given. We do process almost all commodities primarily, but these commodities need harvesting, transport and secondary and tertiary processing by our food industries. They but say, “our most of varieties, especially of fruits and vegetables, are not processable,” and therefore many products are imported. In other side, our farmers are not getting enough income despite bumper production, and thus they must be attracted and retained in food processing business for their produces. Country therefore needs to rethink to enhance income of each citizen for living a dignified life. To achieve so prioritys thrust areas for the country may be as follows:

- (i) Determine the profitable processable characteristics/attributes of Indian agricultural commodities and develop high yielding varieties only for specific purposes so that our food industries use only Indian produce as raw materials and help in establishing micro processing centre in each village (**Collaboration amongst different stakeholders**).
- (ii) Alternatives of cultivating food grains needs to be searched, because how long our natural resources will be available for production of foods are not fully known. Climate change is other big threat to our production system. **Basic and strategic research therefore needs to be started** to manufacture food grains in factory using modern technologies such as biotechnology, nanotechnology, fermentation technologies, super critical extraction, distillation technologies, extrusion technologies and new tools and machinery. Not only India, but the whole world wants food factory to feed ever increasing population.
- (iii) India must go for **precision agriculture, postharvest management and for development of predictive microbiological tools** for majority of commodities at least by 2035; and that is only possible when all agricultural activities of the country is an integrated part of digital India programme. We can play a catalytic role in developing instrument measurable indices/parameters for perceptual attributes such harvesting/maturity or ripeness index, quality index, pricing index (based on nutritional values) etc. of agricultural commodities.
- (iv) We should engage ourselves to develop modern and cheap **community storage structures** for using at *panchayat* or block levels for food grain and on-farm storage structures for

perishables for promoting decentralized storage of food grains and perishables. Development of hybrid cold storage using solar energy may help in reducing post-harvest losses of perishables considerably.

- (v) **Complete biomass (crop residues, fruits and vegetables by-products etc.)** needs to be utilized in better manner for production of energy, high value-low volume compounds and establishment of pilot plants for manufacturing them in production catchments.
- (vi) The traditional and modern fried foods lead to increased level of blood cholesterol. Food Scientists should start working on **development of process protocols and new frying mediums** like fat replacer in food products for zero or minimum absorption of oil/fat by them.
- (vii) India has a treasure of **traditional foods** which are slowly disappearing. This treasure needs to be preserved. Concerted and accelerated efforts are required to **mechanize** the process of the same for quality production without human intervention.
- (viii) Nowadays lifestyle of people, their working environments and climate are cause of various diseases such as headache, cancer, irregular blood pressure etc. We should devote to **develop such disease curing food products**.
- (ix) Food Safety is one of the major concerned for the country. Available test methods are time and resource consuming. Multi-disciplinary efforts are needed to create facilities for working on **sensor and sensor based technology** for in-situ quality check of food, application of artificial intelligence in decision making; internet of things for stored food products for saving them from spoilage.
- (x) **Substantial increase in number of research publications** and their quality, accelerated technology licensing and commercialization, and if possible, establishment of its own products manufacturing and marketing wings for making the institutions financially self-sufficient using all on-line official activities (**paperless administration**)