# NATIONAL SYMPOSIUM

On

## "Sustainability of Agricultural Production and Value Addition in the Context of WTO"

(March 20 - 21, 2003)

**Organised by**

Sher-e-Kashmir
University of Agricultural Sciences and Technology - Jammu
( SKUAST - J )
In collaboration with

**Indian Agricultural Universities Association**
**(IAUA)**

# National Symposium

On

# "Sustainability of Agricultural Production and Value Addition in the Context of WTO"

**(March 20 - 21, 2003)**

*Organised by*

**Sher-e-Kashmir**
**University of Agricultural Sciences and Technology - Jammu**
**( SKUAST - J )**

*In collaboration with*

**Indian Agricultural Universities Association**

**(IAUA)**

# FOREWORD

India has accomplished an impressive progress in agriculture during the last four decades creating self-sufficiency in many and surplus in some commodities. With increased production, production management and value addition assume considerable importance. The post-production management besides being location specific requires different technologies for different commodities. It needs multi-disciplinary technology intervention to improve net availability of food, feed and fiber through scientific conservation. Adopting value addition techniques, the income generation is more besides creating employment opportunities. To capitalize on income induced consumption pattern, expanding domestic market and increased market access and to remain competitive globally, a continuous technology up-gradation is important to lower production cost and to increase productivity and quality of marketable fresh / processed agricultural commodities. With changing use pattern and socio economic compulsions, processing is gaining importance day by day.

For making purposeful and substantiable development of agriculture, it will be essential to change over from a commodity centered approach to farming systems approach. This will also call for multi disciplinary efforts, which will further require emphasis on increasing input use efficiency, sustainability, diversification, post production management, natural resource management, value addition, small farm mechanization, marketing and trade, biodiversity, frontier areas of research to reorient agriculture research and education to develope entrepreneurship to enhance income and employment opportunities. With World Trade Agreement having brought global perspective to agriculture, it is imperative that research reorients its focus on food quality, consumer preferences, environmental concerns and intellectual property rights besides others. Equity, substantiality, nutrition, employment and trade are the new areas of concern for agricultural research, even as efforts to maintain food security continue. These areas make R&D management more complex to harness the outcome of WTO.

The various issues concerning to management of production, marketing, post harvest, value addition and profitability, information technology, increase input use efficiency, crop diversification, quality improvement and enlarging employment opportunities are being considered as pre requisite of sustainable development of agriculture need to be addressed. The subject chosen for National Symposium on "SUSTAINABILITY OF AGRICULTURAL PRODUCTION AND VALUE ADDITION IN THE CONTEXT OF WTO" has significant importance at national as well as international level.

I appreciate and congratulate the organizers of this important symposium, which has great relevance in the context of Indian Agriculture and WTO. The outcome of the symposium in the form of recommendations to be inserted in the proceedings will be of great use to all those engaged in research and development.

(S.B. Singh)
Vice - Chancellor

# PREFACE

*T*hough green revolution, this country has achieved self-sufficiency in cereal grains and this production has to be sustained in view of the continuing increase in our population. Prompt measures are still to be taken for boosting the production of fruits, pulses, oilseeds, vegetables and forages. Ofcourse, an increase in the production of such crops is, limited to the availability of assured irrigation/lifesaving water. Optimum utilization of vastly-available rain-fed land, covering distinctly different agro-climatic regions, is therefore, another emerging need of the present time. For this, rainwater harvesting through development of water-sheds has to be taken on war footing basis. With the formulation and adaptation of WTO, the maintenance of pre and post-harvest quality of our agriculture produce is to be ensured. Our produce and products have to be competitive both in domestic and export markets. This naturally calls for introduction of value-addition measures in our farm produce. Besides, we have to bring improvement in both quantity and quality of our farm produce through gene transfer technology. For sustaining agriculture production and productivity, there has been indiscriminate use of chemicals, fertilizers, insecticides, pesticides and weedicides. This has greatly damaged out friendly eco-environment. Simultaneous introduction of organic farming and bio-control measures is, therefore, another priority area to be taken-up. Another-fast coming need is the optimization of energy uses through improvement of tillage practices and development of specific farm machinery. In view of the prevalence of bio-diversity of agro-climatic conditions in the country, our country also has a vast potential in the production of medicinal / aromatic plants and floriculture.

I am happy to record that this symposium has covered all the above aspects under its five themes, viz (i) scenario in development and acceptability of transgenic crops, (ii) production technology in rain-fed and hilly area, (iii) challenges to Indian agriculture in the context of WTO, (iv) resource conservation technology in agriculture and (v) processing of farm produce and value addition under changing marketing scenario. We are deeply indebted to the Hon'ble Chief

Minister of J&K State and his Cabinet colleagues for readily accepting out invitation to participate in the inaugural session of this national symposium which has been conducted by Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu in collaboration with the Indian Agricultural Universities Association. Their participation has embolden the top dignitaries present in the symposium in their endeavourment of development of agriculture in the country, in general and J&K state in particular. In this symposium, Vice Chancellors of different State Agricultural Universities of the country along with their eminent scientists participated and deliberated on this vital subject of the symposium. In all, eighteen research papers were presented covering the said themes of the symposium. Each presentation was followed by healthy discussion which resulted in some concrete recommendations. Hence, detailed coverage of these lectures in this proceeding will be of great use to those scientists who could not participate in this important national symposium.

(H.U. Khan)

## ACKNOWLEDGMENT

On behalf of the National Organizing Committee of the National Symposium on "Sustainability of Agricultural Production and Value Addition in the Context of WTO", organized by SKUAST-Jammu, in collaboration with IAUA, on March 20 - 21, 2003, I extend my heartfelt gratitude to the following dignitaries and participants of this National Symposium :

Jenab Mufti Mohd Syeed, Hon'ble Chief Minister of Jammu & Kashmir State, for sparing his precious time in gracing the inaugural function of the symposium as its chief guest. His high-valued words of advice will go a long way in encountering the constrains faced for further increasing and sustaining agricultural production. His gracious presence and high-ordered address, covering sound conceptions on the subject, reflected in great inspiration and pleasure to the participants.

Jenab Pt. Mangat Ram Sharma, Hon'ble Deputy Chief Minister of J&K State, for his presence in the inaugural session of the symposium and for giving his valuable message on the subject to the participating delegates.

Jenab Abdul Aziz Zargar, Hon'ble Minister for Agriculture production, Animal Husbandry and Co-operatives, J&K State, for his practical problems-oriented address to the delegates in the inaugural and valedictory functions of the symposium.

Jenab Ajaz Ahmed Khan, Hon'ble Minister of State for Agriculture, for his participation and address in the symposium's valedictory function

The participation of Shri Mushtaq Ganai, Commissioner-cum Secretary to Government, Agriculture Production Department, is thankfully acknowledged.

Prof. S.B. Singh, distinguished Vice Chancellor of CSAU&T, Kanpur, and President, IAUA and Chief Patron of this symposium, for his presidential address.

Prof. H.U. Khan, distinguished Vice Chancellor of SKUAST Jammu, and Patron of this symposium for his keynote address highlighting future strategies for further increasing agricultural production and its sustainability.

The presence in this symposium of various Heads of Developmental Departments of J&K Govt. and /or their representatives is gratefully acknowledged.

The messages received for this symposium from (i) His Excellency the President of India, (ii) Minister of Agriculture, Govt., of India, (iii) His Excellency the Governor of J&K State, (iv) Hon'ble Chief Minister, J&K State, (v) Hon'ble Deputy Chief Minister, J&K State, (vi) Hon'ble Minister for Agriculture production, Animal Husbandry and Co-operative, J&K State, (vii) Hon'ble Minister of State for Agriculture, (viii) Chief Secretary, J&K Govt., (ix) President, IAUA and (x) Vice Chancellor, SKUAST-Jammu, have been of great strength, value and inspiration for the participants of the symposium.

Renowned scientists from different parts of the country for presenting their papers covering different sub-themes falling under the main theme of the symposium.

University officers and scientists, including various committee members, of SKUAST-Jammu, for their efficient and active involvement in the successful conductance of the symposium.

Hospitability gestures, in terms of hosting of breakfasts or lunches or dinners, extended by Hon'ble Chief Minister, J&K State, Chairman J&K Bank Ltd., IFFCO, Kohinoor International and Chamber of Commerce, are thankfully acknowledged.

(Dr. Rangil Singh)
Organizing Secretary

# National Organizing Committee

Chief Patron : Dr. S.B. Singh
Vice Chancellor
CSAUAT, Kanpur &
President, IAUA

Patron : Prof. H.U. Khan
Vice Chancellor
SKUAST- Jammu

Members :

1. Dr. S.S. Baghel
   Vice Chancellor
   CAU, Imphal
   & Vice President, IAUA
2. Dr. S.N. Puri
   Vice Chancellor
   MPKV, Rahuri
   & Secy-Treasurer, IAUA.
3. Dr. Abdul Rashid
   Director Resident Instructions &
   Dean PGs.
4. Dr. M.P. Gupta
   Director Extension Education
5. Dr. Rangil Singh
   Director Research &
   Organising Secretary
6. Dr. A.R. Nazki
   Registrar
7. Shri V.K. Soi
   Comptroller
8. Shri S.K. Gupta
   PP& MO
9. Dr. J.S Bijral
   Associate Dean, FOA
10. Dr. N.A. Sudhan
    Associate Dean, FVSc.& AH

# INAUGURAL AND VALEDICTORY FUNCTIONS

## INAUGURAL

1. Saraswati Vandana

2. Welcome address by Director Research & Organizing Secretary SKUAST-Jammu.

3. Key note address by Vice Chancellor SKUAST-Jammu

4. Presidential address by President, IAUA

5. Address by Hon'ble Minister for Agriculture Production, Animal Husbandry & Co-operative, J&K

6. Address by Hon'ble Deputy Chief Minister,J&K

7. Address by the Hon'ble Chief Minister, J&K & the Chief Guest of the occasion

8. Vote of thanks by Director, Resident Instructions Cum-Dean, PGS, SKUAST-Jammu.

## VALEDICTORY

1. Opening address by Vice Chancellor, SKUAST-Jammu.

2. Presentation of technical sessions' reports by rapporteurs.

| | | |
|---|---|---|
| Session-I | : | Dr. R.M. Bhagat |
| Session-II | : | Dr. J.S. Jamwal |
| Session-III | : | Dr. C.S. Kalha |
| Session-IV | : | Dr. R.K. Gupta |
| Session-V | : | Dr. A.S. Bali |

3. Address by Commissioner-cum-Secretary to Govt. Agricultural Production Deptt., J&K
4. Address by Hon'ble Minister of State for Agriculture, J&K.
5. Address by Hon'ble Minister for Agriculture & Co-operative, J&K
6. Vote of thanks by Registrar, SKUAST-Jammu.

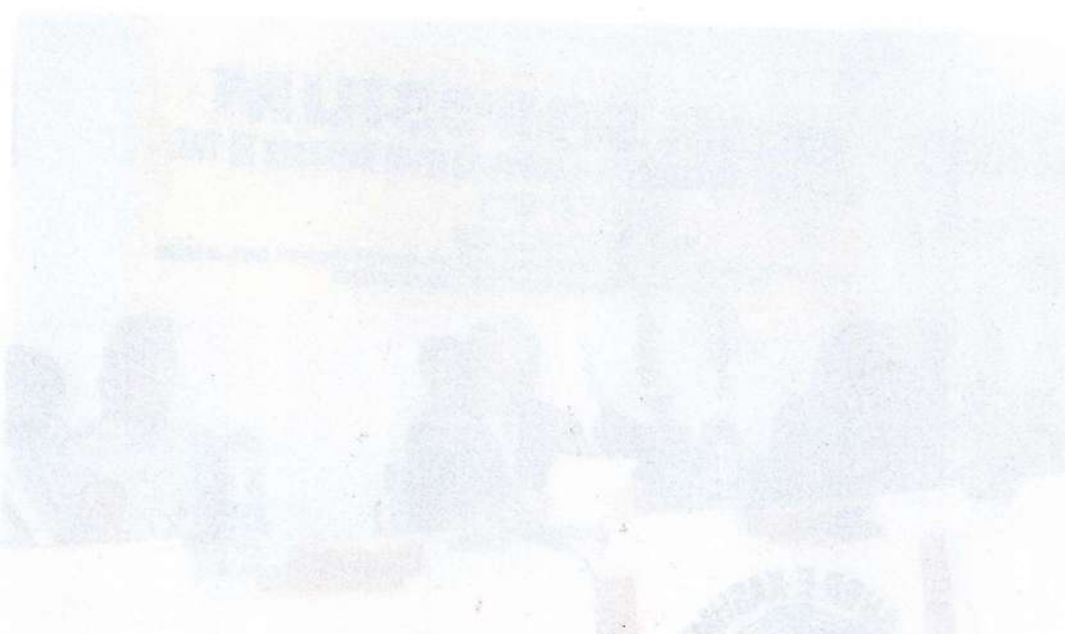
# GLIMPSES OF NATIONAL SYMPOSIUM


ADDITION IN THE


NATIONAL SYMPOSIUM
CONTEXT OF WTO
20-21,2003
ASSOCIATION


NATIONAL SYMPOSIUM
ON
SUSTAINABILITY OF AGRICULTURAL PRODUCTION & VALUE ADDITION IN THE
CONTEXT OF WTO
MARCH 20-21, 2003
SHER-E-KASHMIR UNIVERSITY OF AGRICULTURAL SCIENCES & TECHNOLOGY, JAMMU
AND INDIAN AGRICULTURAL UNIVERSITIES ASSOCIATION
SHER-E-KASHMIR


SYMPOSIUM
VALUE ADDITION IN THE
20-21,2003
UNIVERSITIES ASSOCIATION
SHER-E-KASHMIR




SYMPOSIUM
ON
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ADDITION IN THE
TEXT OF WTO
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SHER-E-KASHMIR

राष्ट्रपति के प्रेस सचिव

*Press Secretary to the President*

राष्ट्रपति सचिवालय
राष्ट्रपति भवन
नई दिल्ली – 110004

*President's Secretariat*
*Rashtrapati Bhavan*
*New Delhi - 110004*

**MESSAGE**

The President of India, Dr. A.P.J. Abdul Kalam, is happy to know that Sher-e-Kashmir University of Agricultural Science and Technology, Jammu in collaboration with Indian Agricultural Universities' Association is organising National Symposium on "Sustainability of Agricultural Production and Value Addition in the Context of WTO" on 20th and 21st March, 2003.

The President hopes that the Conference will give an opportunity to the experts in the field to discuss various issues related to productivity and value addition.

The President extends his warm greetings and felicitations to the organisers and the participants and sends his best wishes for the success of the Symposium.

PRESS SECRETARY TO THE PRESIDENT

राष्ट्रपति सचिवालय
राष्ट्रपति भवन
नई दिल्ली - 110004
*President's Secretariat*
*Rashtrapati Bhavan*
*New Delhi - 110004*

राष्ट्रपति के प्रेस सचिव
*Press Secretary to the President*



MESSAGE

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The President hopes that the Conference will give an opportunity to the experts in the field to discuss various issues related to productivity and value addition.

The President extends his warm greetings and felicitations to the organisers and the participants and sends his best wishes for the success of the Symposium.

PRESS SECRETARY TO THE PRESIDENT

अजित सिंह
AJIT SINGH

कृषि मंत्री
भारत सरकार
कृषि भवन
नई दिल्ली–110 001
MINISTER FOR AGRICULTURE
GOVERNMENT OF INDIA
KRISHI BHAWAN
NEW DELHI 110 001

# MESSAGE

I have great pleasure to learn that the "National Symposium on Sustainability of Agricultural production and Value Addition in the context of WTO" is being organized in collaboration with Indian Agricultural Universities' Association on March 20 - 21, 2003. It is extremely important for all of us to build on our own strength and take advantage of the opportunities offered by the WTO Agreement on Agriculture. The WTO has opened a whole gamut of challenges as well as threats for which India has to prepare itself to reap potential grains by way of larger exports and higher incomes for the farmers. We will have to make our agriculture competitive internationally. We, at the same time, need to remain alert to obviate indiscriminate import of cheap foreign agricultural products, which not only hamper our own agricultural production but may also jeopardize the Indian farmers.

The domestic support that we provide to the Indian agriculture is well within the norms set by the WTO Agreement on Agriculture. In fact, the level of domestic support to our agriculture is not limited by any conditions specified by the Agreement on Agriculture but is constrained by the availability of resources. To protect and support the agriculture sector to meet the challenges of globalization and liberalization, we will have to focus on infrastructure, watershed development, increased availability of quality inputs, quality improvement of the grain and agricultural commodities and greater thrust upon research and extension.

One of the important dimensions of our coping strategies to derive maximum mileage in the era of agricultural trade liberalization is to enhance our efficiency of crop production. For this purpose, the thrust is required to be given to increase the productivity. We already have comparative advantage for several crops like rice and horticulture crops. The efficient use of inputs and induction of research and technology can go a long way in furthering our comparative advantage.

The international trade has it own yardsticks of sanitary and phyto-sanitary conditions and these aspects have to be taken note of in our crop production system. Besides increasing the productivity, therefore, the adherence of the quality standards is also essential for gaining market access. I do hope that this National Symposium will bring out concreate proposals which would help in formulating further strategies in the new era.

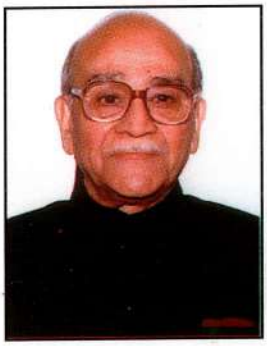
I wish the National Symposium all Success.

(Ajit Singh)

GOVERNOR
JAMMU & KASHMIR

RAJ BHAVAN
JAMMU-180001

March 8, 2003.



## MESSAGE

I am glad to learn that the Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, in collaboration with the Indian Agricultural Universities Association, is organizing a National Symposium on "Sustainability of Agricultural Production and Value Addition in the Context of WTO" on March 20-21, 2003.

In view of the substantial changes taking place in the field of agricultural production because of rapid technological advances and liberalized trade regulations under the WTO regime, the theme of the Symposium is currently of much material importance. These developments and connected aspects also need the special attention of agricultural scientists, entrepreneurs and policy planners so that we can better deal with the challenges and capitalize on the opportunities of the new agricultural economy. Agriculture and Horticulture are the backbone of our State's economy. I am sure that our agriculturists and development agencies will greatly benefit from the deliberations at this Conference.

I extend my warm greetings and best wishes to the organizers and the Vice-Chancellors, eminent scientists and others taking part in this National Symposium.

(Girish Chandra Saxena)

CHIEF MINISTER
JAMMU AND KASHMIR

*Mufti Mohammad Sayeed*

## MESSAGE

I am glad the Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu is organizing a Symposium on **"Sustainability of Agricultural Production and Value Addition in the Context of WTO".**

While the Indian green revolution has impressed the world and changed the food scenario of the country, much remains to be done to remove the social imbalances that crept in along the way. The sustainability of agricultural activity as a remunerative business in a transforming economy which is pushing the farms out of focus and making factories more and more lucrative, is emerging as a challenge for the scientists. Lessons of the recent past show that increasing productivity is not enough to prevent individual disaster on the farm land leading to suicides. In this world of competition, agriculture has to sustain itself as a remunerative business.

I wish the organizers of the symposium well and hope that it will come up with answers to our problems on the agricultural front with special focus on J&K.

(Mufti Mohammad Sayeed)
2. 3. 2003

DEPUTY CHIEF MINISTER
JAMMU AND KASHMIR

Mangat Ram Sharma

## *Message*

*It gives me an immense pleasure to know that Sher-e-Kashmir University of Agricultural Sciences and Technology- Jammu is organizing a National Symposium on Sustainability of Agricultural Production and Value Addition Universities Association, New Delhi, on 20-21 March 2003. Through green revolution, we have already achieved in the country a self-sufficiency in food grains and, through white revolution, the country is aheading to achieve similar position in milk production. Progress made in the production of agriculture and its allied sectors have changed the status of our country from an importer to an exporter one. However, in the present scenario of globalization in marketing system through WTO, our agricultural produce has to be competitive. Jammu&Kashmir State is uniquely bestowed with diversified agro-climatic zones and, for this, can be safely termed as mini-India. The State has a vast potential in exploitation of agriculture, horticulture, medicinal/aromatic plants, vegetables, floriculture and sericulture. The pasturage available provides excellent opportunities for rearing of increasing population of large as well as small animals. With increasing population, the productivity in agriculture is to be increased and sustained. I hope that the deliberations in this symposium through the attending galaxy of Vice-Chancellors of agricultural universities and other eminent scientists from all over the country will help in formulation of strategies for sustaining the growth of agriculture both in terms of quality and quantity.*

*I wish the symposium a great success.*

Mangat Ram Sharma

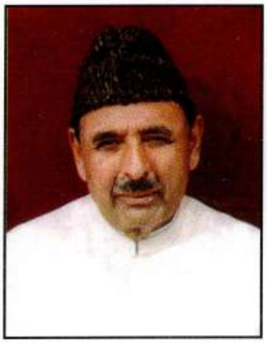
*Deputy Chief Minister*
*(J&K State)*

A. A. Zargar

Ph. : (O) . (R) 2549690
MINISTER FOR
AGRICULTURE PRODUCTION,
ANIMAL HUSBANDARY AND CO-OPERATIVE

D. O. No.

Dated :



**MESSAGE**

I am happy to learn that Sher-e-Kashmir University of Agriculture Sciences and Technology, Jammu is organizing a National Symposium on Sustainability of Agriculture Production and Value Addition in the Context of WTO in collaboration with Indian Agriculture Universities Association, New Delhi on March 20-21, 2003. the green revolution followed by white revolution in the country have resulted in boosting the production of food grains and Milk, respectively. The progress in Agriculture sector of Jammu & Kashmir State, which is gifted with diverse flora and fauna, has to be brought at par with national and international standards. In this direction, we have to take full advantage of the prevalence of wild diversity of agro-climatic conditions in this State and exploit the same for further increase the production in fruit crops, vegetables, pulses, oil seeds, forages, medicinal/aromatic plants, floriculture and sericulture. Under world trade Organization (WTO), the maintenance of pre and post harvest quality of agricultural produces is to be ensured. Our produce and products have to be competitive both in domestic and export market. I hope the discussions and interaction of vice Chancellors of State Agriculture Universities and other eminent scientists of the country will result in fruitful recommendations which will be need-based and location-specific to bring this state and the country at par with international standards in both quantity and quality of agriculture produce. I wish this symposium a great success.

**(A.A. Zargar)**

## MESSAGE

I feel delighted to know that the Sher-e-Kashmir University of Agriculture Science and Technology, Jammu is organizing a national Symposium on "Sustainability of Agricultural Production and Value Addition in the Context of WTO" in collaboration with Indian Agricultural Universities' Association on March 20-21, 2003 in this University. The agriculture is the mainstay of the State Economy and it contributes about 33.41% of the net state domestic product. About 80% of the people are directly related to this sector. These people are directly dependent on agriculture and its allied activities, as the sector generates employment in rural areas on off season and regular basis for a large weaker section of the populace – the illiterate, the handicapped, the old & over aged, the village women besides the educated class. The state rural economy wheels get constantly greased through regular money in-flow on sales of agricultural products. Besides the farming community, the other connected agencies like the transporters, packaging manufacturers, the business class, the laborers etc. thrive mainly on this sector.

It is an encouraging fact that much progress has been made in this sector by the state which is clear from the fact that the overage production of rice, wheat, maize has increased to a level of 17.0, 5.2 and 15.9 quintals per hectare during the year 2000-2001.The production of fruit has increased to 11 lac MTs as against 16000 Mts of 1953-54. The apple productivity is about 10.72 TS per hectare, which is of course highest compared to other states of India matching of course world average of 11.06 MTs. However, we are far behind Belgium 146.51 MT/hectare; Denmark 41.87; Netherlands 40.49; New Zealand 40.13; Brazil 30.63; U.S.A. 25.90; Turkey 23.45 and Iran 13.75. MT / Ha .

However, with the on set of globalization and open market policy under W.T.O. agriculture produce has to face a large competition in the open world market. It has to compete interms of quality and not quantity. Therefore, the need of the hour is that we will have to lay a great stress on production of the quality farm products / fruits diversification of traditional crops by cash crops besides, ensuring proper value addition through cold chain and proper grading and packing so that it can meet the international standards.

The Agricultural Universities will have to play a vital role in developing new hybrid, varieties which are not only resistant to drought and diseases; but match the international standards qualitatively. Therefore the agricultural scientists and experts will have to work tirelessly for ensuring sustainability of the agriculture sector. I hope this Symposium will go a long way in their way of achieving the goal in minimum possible time.

Ch. Ajaz Ahmad Khan

Jammu
25th February 2003

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद्
कृषि मंत्रालय, कृषि भवन, नई दिल्ली - 110 001

सत्यमेव जयते

**DR. MANGALA RAI**

SECRETARY
&
DIRECTOR-GENERAL

GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
MINISTRY OF AGRICULTURE, KRISHI BHAVAN, NEW DELHI - 110001
Tel. 2338 2629; Fax 91-011-2338 7293; E-mail: mrai@icar.delhi.nic.in

March 4, 2003

## MESSAGE

In the wake of changes in international trade scenario since the last decade, several new issues, which impact upon Indian agriculture as well, have cropped up for additional efforts on our part. At the same time, the requirements of care and action on basic issues, e.g. optimal management of agriculture production systems, wider adoption of resource conservation technologies etc., remain as important as ever before to ensure much-needed equitable development in the country. While considering both old and new issues, we realize that the complexities are on the increase. Thus, it has to be a continuing exercise to dwell on delineating these issues to develop and refine our perspective and action plan.

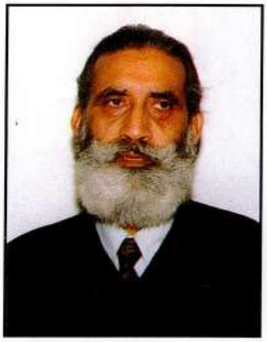
I am, indeed, happy that the Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu has taken another initiative in collaboration with the Indian Agricultural Universities Association in this direction. The themes selected for technical sessions for the National Symposium on "Sustainability of Agricultural Production and Value Addition in the Context of WTO" being organized during March 20 - 21, 2003 are topical, cover the broad issues requiring deliberations, and should certainly add to current understanding. What we really require is a detailed exercise covering all possible elements, whether related to policy, administration, research, extension or development.

While congratulating the organizers for this initiative, I extend my warm wishes for a very useful outcome.

(MANGALA RAI)

CHIEF SECRETARY
JAMMU AND KASHMIR

Dr. Sudhir S. Bloeria



# M E S S A G E

I am happy to know that Sher-e-Kashmir University of Agriculture Sciences & Technology is organizing a National Symposium on 'Sustainability of Agricultural Production & Value Addition in the Context of WTO' on 20-21 March, 2003.

I am sure this would provide a useful opportunity to educationists and scientists to share their experiences and matters of scientific interest which could help in boosting the agricultural production in the given context.

I felicitate the organizers and wish the symposium a success.

**(Dr.Sudhir S.Bloeria)**

Jammu the
27th Feb.,2003.

# INDIAN AGRICULTURAL UNIVERSITIES ASSOCIATION

Reg. No. 3498-10-11-67

Dr. S. B. Singh
President
&
Vice-Chancellor

C.S. Azad University of Agirculture & Technology, Kanpur-208 002
Phone : Off : 2294557 (O) 2294558 (R)
Fax : 2210408

IG-2, C.G.I.A.R. Block, National Agricultural Sciences Complex Dev Prakash Shastri Marg, Pusa Campus New Delhi - 12
Fax & Tel. : 011-25821422
E-mail Address : esiaua@yahoo.co.in

Dated: 10 March, 2003

## MESSAGE

It is indeed a pleasure to know that Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu in collaboration with Indian Agricultural Universities Association (IAUA) is organizing the National Symposium on "**Sustainability of Agricultural Production and Value Addition in the Context of WTO**" from March 20-21, 2003 which is being attended by Vice Chancellors of the SAUs and Central Agricultural Universities as well as other renowned Scientists of the country are participating.

The symposium envisage to comprehensively deliberate on issues encompassing judicious utilization of natural resources with diverse agro climatic conditions, human resource, technological knowhow available in the country for optimum and quality production of food grain, fruits, vegetables, animal products without affecting ecosystem so as to benefit termining million of world humanity in general and countrymen in particular.

I wish the symposium a grand success.

10/3/03

**(S.B. Singh)**

**Sher - e- Kashmir**
**University of Agricultural Sciences & Technology**
Head Office, Rail Head Complex, Jammu - 180 012

**Hashmat-Ullah-Khan**
Vice-Chancellor

D. O. No. :
Dated :

## MESSAGE

Agriculture today has turned out to be a complex activity, in which education, research and extension have become complimentary to each other. India will need about 240 million tonnes of food grains by the turn of this decade. Thus, there is no room of complicency looking towards ever increasing demand for food, fibre, fuel and fodder on one hand and deterioration in the environment due to indiscriminate use of available resources on the other hand. The goal has to be not only to provide nutritional security but also produce and export surplus to earn more foreign exchange and generate self-employment in the sector. New approaches like adoption of alternate farming practices, use of bio-fertilizers, integrated management systems, on water, pesticides and fertilizers have to be practiced. Similarly, policy initiatives have to be taken to meet the challenges of globalization.

It is in this context that this university in collaboration with Indian Agricultural Universities Association has organised this National Symposium on "Sustainability of Agricultural Production and Value Addition in the context of WTO". I am sure that the deliberations during the Symposium will culminate in bringing up concrete recommendations to meet challenges posed by WTO.

I wish the symposium grand success.

**(H. U. Khan)**
Vice Chancellor

## LOCAL ORGANIZING COMMITTEE

| | |
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# Contents

# Advances in the bioregulation of sucrose partitioning determining seed quality in cereals and chickpea

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## ABSTRACT

Biomass accumulation determining crop yield is a net result of the unhampered operation of three principal biological processes, namely photosynthetic reduction of $CO_2$, reduction of diatomic/nitrogenous nitrogen and biological oxidation. In cereal grains, starch is the principal storage carbohydrate and next in concentration to starch in these grains is the protein. The yield and quality of such grains is, therefore, determined by the rate at which these macromolecules are synthesized during grain filling which, in turn, depends on an uninterrupted assimilate supply to the seed formation region. Imported sugars, particularly sucrose, are fastly converted to starch, besides their utilization in the generation of keto acids and, thereby, amino acids which becomes the monomers of protein. Chickpea seed possess an ideal cereal-pulse-combination with respect to starch and protein. Current scientific approach in this direction is to incorporate this nutrient combination of chickpea seed into cereal grain. For this, bioregulatory processes channelizing arriving sucrose between starch and protein in the grain/seed of cereals and chickpea need to be ascertained and their enzymic mediation, as operating in their micro environments *in vivo*, needs to be identified. Cereal grains are inadequate in some essential amino acids and to improve their protein quality, underlying causes of such inadequacy need to be elucidated. To mimic *in vivo* grain conditions, liquid culturing of detached infloresences/earheads in manipulated media have given convincing result and is a potent experimental approach for bringing improvement in the pre-harvest quality of cereals grains.

## Introduction

Through green revolution, India has achieved self-sufficiency in food grains, particularly in cereals, yet this revolution has to be attained in pulses, oilseeds, vegetables and fruits etc. Under the newly opened umbrella of WTO, where India is a signatory, the attainment of pre- and post-harvest quality improvement of agricultural produce is to be ensured. This is essential to reduce the number of under-nourished people in our country. Our produce has to be competitive not only in domestic market but also in the export market. Achieving quality standards in our agricultural produce is, therefore, one of the priority needs for which we have to bring vertical improvement. For this, post-harvest value additions relevant to specific crop products, is of course, one approach but an alternate approach of a permanent nature is to bring pre-harvest improvement in grain quality. The accumulation of bio-mass and, thereby, grain quantity and quality depends on the rate of synthesis of starch and protein during grain filling. This, in turn, depends upon an unhampered sucrose and amino nitrogen supply in assimilates entering the sink region of grain. Sucrose is synthesized in photosynthetic tissues even before the appearance of free monosaccharides and in the formation of this disaccharide the solar energy is trapped in chemical energy form. On the catabolism of sucrose, an energy currency as ATP is generated for various cellular functions like regulatory work, chemical work, osmotic work etc. Obviously, in higher plants the position of sucrose as translocate as well as fuel molecule for respiratory furnace of the cell is analogous to that of glucose in animals. Once the photosynthetic leaf acquires 1/3$^{rd}$ of its final growth size, it starts exporting sucrose to sink regions, including that of developing grains, and this export continues with the advancement in the growth of leaf. Thus, the level of this sugar in leaf does not increase with the advancement in plant growth. During germination of seeds also, this disaccharide is generated as principal sugar translocate for utilization in growing region of the plants, irrespective of whether the storage forms of seed constituents are starch or fats or proteins or galactomannans. Of course, there is an exception to this generalization which is met in some plants, like cucumber, where galactocylated derivatives of sucrose (raffinose-oligosaccharides) constitute their transport streams but in such cases too sucrose is generated at the final delivery point. Hence, understanding the bioregulatory partitioning of sucrose between starch and protein synthesis during grain filling is the current priority concern in plant biochemistry research. The experimental observations presented in this paper are, therefore, focussed in this direction. Through understanding at molecular level the bioregulation of starch and protein accumulation in developing cereal grain, a future possibility of incorporating an ideal starch-protein combination present in chickpea seed, in the grains of both $C_3$ and $C_4$ cereals been envisaged. Newly-emerging technological approaches for correcting the essential amino acids inadequacy, existing in cereal grain proteins, have also been discussed. Culturing detached earheads/inflorescences in liquid medium, manipulated exogenously with respect to sugars, amino nitrogen, phytohormones and enzyme regulators, has emerged as a potential approach in illucidating the bioregulation and partitioning of sucrose between starch and protein during grain/seed filling in cereals and chickpea. Employing this technique, in conjunction with radiotracers, vital clues towards improving protein quantity and quality in the grains of cereals and chickpea have been obtained. The work reported in this paper is based on author's long-term involvement and stands largely published in the national/international journal of high repute.

**Choice of sucrose as translocate**

In fully expanded leaf, around 50% of photosynthetically fixed carbon is exported as sucrose to sink regions including developing grains. Apparently, sucrose exists in source tissue in two distinct pools. One pool is meant for sucrose transport and the other is meant for sucrose storage. The mobile transport pool seems to be located in the cytoplasm whereas the non-transport pool exists in the vacuole. Interestingly, in source tissue sucrose gets readily loaded in the phloem where as other accompanying free sugars are retained. The pertinent question, however, is why sucrose has been chosen as a sugar of choice for transport in higher plants. One possible reason in this context is that sucrose, being non-reducing, is chemically less reactive during its transportation from source to sink. This is because of the presence in this molecule of á (1→2) glycosidic linkage between its two anomeric carbons. Through this linkage, the reducing aldehyde and keto groups of á D-glucopyranose and â-D-fructofurnose moieties of sucrose are protected from interaction with other metabolites during its translocation and this is quoted as one reason in the selection of sucrose as translocate. If this is so, then why other glycosides, having aglycons (like phenols), do not serve the same purpose. The negative points put forth in such cases are: (i) mostly aldohexoses are linked with aglycons and ketohexoses are very rarely linked through such linkages and (ii) the aglycon moieties on release in the sink region may prove toxic. Additionally, since plants are much more vulnerable than animals to damage from external forces like predators and diseases, so a relatively less reactive sugar like sucrose is not unnecessarily metabolized. When etiolated pea epicotyls were aseptically cultured in complete liquid medium containing sucrose or hexose(s), sucrose supported better growth over hexoses in terms of both elongation and weight. In such a system, the movement of sucrose and its hexose moieties from culture medium encountered mature cells, elongating cells and dividing cells. The asymmetry in tissue of the extracted sucrose from the equilibriated metabolic pool of hexoses. Such studies clearly indicated that in the elongating region of the plant, the hydrolysis of sucrose is necessary before it gets further metabolized. Since sucrose cannot enter as such into non-vascular cells through their plasma membranes, so it has to be obligatorily cleaved by extra-protoplastic invertase the level of which is regulated by a phytohormone, namely indoleacetic acid. Another conceivable reason in favour of the selection of sucrose as translocate is its high free energy of hydrolysis (-6.6 Kcal./mole) of its glycosidic bond which may be an additional plus point in the selection of this sugar as an ideal translocate. This high negative free energy of hydrolysis is comparable to that of ATP (-7.3 Kcal/mole). However, this advantageous point is dismissed on the plea that starting with stage of inversion of sucrose followed by complete biological oxidation of its released hexose moieties, there is a gain of only 1.3% in the potential metabolic free energy of this disaccharide over its invert sugars and this, of course, is a marginal increase. In the absence of any viable reason(s), the selection of sucrose as the translocate of choice is still an open question.

**Studying sucrose metabolism under *In Vivo* conditions**

The results obtained on the kinetic parameters of isolated enzymes do not always hold true for their naturally-existing *in vivo* conditions of the plant. Hence, to study the bioregulatory metabolism of any metabolite, it is necessary to closely mimic its *in vivo* conditions. For instance, the Km value of an enzyme, for a particular substrate, determined *in vitro,* may not be same as may exist under its *in vivo* environment. On isolation, the enzymes, particularly regulatory ones, may lose their regulatory properties. The co-operative action exhibited by some enzymes *in vitro* may not be true for *in vivo* conditions where such enzymes may not be existing in close proximity. Hence, the results obtained *in vitro* may be artifactual. It becomes, therefore, necessary not to disturb the intra- and extra protoplastic environments of enzymes and for this liquid culturing of organs, tissues, cells, protoplasts and organelles is a potent technique. In the presentation in this paper of the research work, the employment of some such systems has been incorporated. This includes culturing of detached earheads of cereals and inflorescences of chickpea in exogenously manipulated liquid media. Infact, in the conductance of research under report, the author has successfully developed and made intensive use of liquid-culture technique to understand regulatory metabolism of sucrose during seed filling in these important crop plants. In doing so, the effort has been to provide an *in vivo* mimicker for the naturally existing conditions under which metabolic regulation of sucrose occurs in relation to source-path-sink operation.

**Transformation of sucrose to starch in developing seed**

During grain filling, the translocated sucrose, whether entering the grain as such like in wheat grain or after inversion like in maize kernel, is channelized for the synthesis of storage starch, storage protein and, to a small extent, storage lipids. Between invertase and sucrose-UDP (ADP) glucosyl transferase, the two sucrose cleaving enzymes, the former is more active at an early stage of grain growth. However, with the increase in the rate of starch accumulation, the non-hydrolytic cleavage of sucrose catalysed by sucrose synthase (reversal) increases. The UDP-glucose formed by sucrose synthase-catalysed cleavage of sucrose is converted via the formation of glucose-1-phosphate, which is also generated upon phosporylation of hexoses, to ADP-glucose. This nucleotide sugar then becomes an immediate donor of glucose in the starch synthesis catalyzed by starch synthase. In a systematic study on starch accumulation during grain filling in both waxy and non-waxy rices, it has been demonstrated that the rate of starch accumulation slows down when the free sugar content is still adequate in the grains. In wheat also, inspite of an adequacy of free sugars in grains, peduncle, rachis and bracts, there was a decline in daily rate of starch synthesis beyond 24 days post anthesis. This is a reflection of cessation of starch-synthesizing capacity of the grain sink. This decline is, not therefore, the result of an onset of grain desiccation rather desiccation is the result of metabolic failure in the developing grain to transform free sugars to starch. Obviously, the accumulation of starch during grain growth is under the control of some intrinsic factors, including enzymes, which operate both within and outside the grain. These bioregulatory factors may be involved in (i) sucrose transport into the cells of growing endosperm or cotyledons, (ii) rates of enzyme-catalysed reactions involved in sucrose utilization in anabolic processes, grain respiration and (iii) elastic properties of the outer seed layers. Sucrose-UDP glucosyl transphase and invertase seem to be the first set of regulatory enzymes in sucrose utilization. ADP-dependant sucrose synthase is strongly inhibited by UDP. Hence, the intracellular level of this nucleoside diphosphate seems to regulate the activity of this enzyme. Inorganic pyrophosphate (PPi) is required in a mole-to-mole ratio during the UDP-glucose pyrophosphorylase-catalysed conversion of UDP-glucose to glucose-1-phosphate which is then converted to ADP-glucose by ADP-glucose pyrophosphorylase. The operation of inorganic pyrophosphatase, another important regulatory enzyme, may be encountering a reaction-rate limitation created at the level of its substrate (i.e. PPi) concentration. Based on the activity pattern of this enzyme in endosperm during grain filling in wheat, a vital role played by the stated enzyme in the transformation of sucrose to starch has been revealed. This enzyme ensures the removal of PPi released during ADP-glucose pyrophosphorylase to ADP-glucose, as PPi build-up beyond a level starts inhibiting ADP-glucose pyrophosphorylase.

The utilization ofglucose-1-phosphate in the generation of ADP-glucose via ADP-glucose pyrophosphorylase catalysis appears to be a driving force for sucrose utilization in the developing grain. On studying the pattern of the activity of 3PGA-phosphatase in relation to the content of chlorophyll in developing rice caryopsis, the mediating rate of some metabolite(s) generated through chlorophyll involvement was conceived. One such biosynthetic product was found to be 3PGA the concentration of which was under the regulatory control of 3PGA phosphatase. The activity of this enzyme is concentrated largely in the pericarp-aleurone. This experimental evidence led to the suggestion that 3PGA and Pi regulate starch accumulation in the endosperm by controlling ADP-glucose pyrophosphorylase activity. Since ADP-glucose pyrophosphorylase is activated by 3PGA and inhibited by Pi, the concentrations of which are under the light regulatory control of 3PGA phosphatase, so starch accumulation in developing grain, with special reference to rice grain, seems to be mediated by 3PGA phosphatase of the pericarp. Another emerging question is what factors, generated through light mediation in earheads, are involved in grain filling in cereals. In this direction, a possibility of the involvement of some phytohormones, the synthesis of which is dependent on light intensity, has been evidenced. High activities of amylases observed in pericarp-aleurone during initial grain growing stages in wheat reflects the involvement of these enzymes in the break down of starch in pericarp to produce glucose, maltose and mato-oligosaccharides for subsequent use as primers and/or in respiration during starch synthesis in endosperm cells. Because of the potential toxicity of free galactose, the glactocylated derivatives of sucrose (i.e. raffinose-series oligosaccharides) are synthesized. From such derivatives, the required glactose may be derived for the synthesis of glycoproteins in grain. The activity patterns of UDP-glucose pyrophosphorylase, ADP-glucose pyrophosphorylase and alkaline inorganic pyro-phosphatase closely follow the rate of starch accumulation in the caryopsis. Exogenous feeding, through liquid culturing of Pi to the developing grains of wheat and sorghum resulted in a drastic reduction in the incorporation of $^{14}C$ from sucrose to starch in sorghum ($C_4$ cereal) grain as compare to wheat ($C_3$ cereal) grain. This experimental evidence led to the suggestion that the transformation of sucrose to starch in developing grains of wheat and sorghum occurs through different metabolic routes which have been formulated and proposed for these cereals. Accordingly, the starch precursor entering sorghum grain amyloplast is triose phosphate mediated by a triose phosphate/Pi translocator in the amyloplast membrane. In contrast, hexose phosphate and ADP-glucose may act as direct precursors of starch synthesis in wheat grain. Such precursors enter amyloplast of this cereal grain through specific translocators, namely hexose phosphate translocator and adenylote translocator.

**Pre-harvest improvement in -seed-protection quantity and quality**

Through soil application of nitrogenous fertilizers and conventional breeding, the possibility of an increase in protein content of cereal grain is marginal. With an available background evidence that, in comparison to regulated import of sucrose, there is an unregulated import of amino nitrogen in wheat grain, a major increase in protein synthesis in the grains of $C_3$ cereals, as a result of increase in glutamine feeding through liquid culturing, has been demonstrated. This increase in exogenously-fed amino nitrogen through the culture medium also resulted in an enhancement in the activities of transaminases, namely glutamate oxaloacetate transminase, glutamate pyruvate transaminase, in developing chickpea seed. The activities of these enzymes has also been shown to increase in this legume seed by exogenous feeding through liquid culture of pyridoxal phosphate. However, the amino nitrogen supply has to be in proper ratio with sucrose concentration in the transport stream entering the growing grain. By increasing amino nitrogen in the form of glutamine with, of course, an adequate accompanying sucrose in the transport stream entering the grain, it has become reasonable to put forth that during grain filling it is possible to divert sucrose from starch to protein synthesis. On SDS-gel-electrophoresis of the proteins in rice grains, raised through liquid culture, the pattern of protein sub-units was found to be the same as obtained in the field-raised grains. Obviously, the so increase in grain protein content in rice does not represent the synthesis of small polypeptides. It has also been shown that in cereal grain the protein fractions like albumins (water soluble) and globulins (salt soluble), which are formed during early stages of grain growth, are rich in lysine. However, storage proteins, namely prolamin (alcohol soluble) and glutamine (alkali soluble), are poor in lysine and this lysine deficiency is more in prolamin than glutamine. The accumulation of lysine-poor proteins towards grain maturity was shown to be due to inadequate lysine in the amino acid pool of the maturing grain. This lysine inadequacy was shown to be caused by lysine-keto glutarate reductase, a lysine catabolism enzyme. Since chickpea has an ideal cereal pulse combination, having levels of starch and protein as 55 and 22-25%, respectively, so it was envisaged that chickpea seed possesses some inhibitor(s) of this lysine-catabolising enzyme. Infact, experimental evidence has been obtained to support this important emerging view point on the subject. By exogenously feeding lysine as well as protein fractionated chickpea extracts, through liquid culturing, to developing wheat grain, an increase in its lysine-rich storage proteins has been shown. From such authentic experimental evidence, it becomes reasonable to suggest that through insertion of the gene, expressing for lysine- catabolising enzyme inhibitor, from chickpea seed into wheat grain is the future potent transgenic approach in improving the pre-harvest protein quantity and quality in cereal grains.

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## Sustainability of Agriculture in High Potential Areas in the Context of WTO

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The Agreement on Agriculture as a part of Multilateral Trade Negotiations signed by the member countries in April 1994, at Marrakesh, Morocco came in force in June, 1995. It had the basic objective of minimizing the use of natural resources in the world by having fair market oriented trading system among different countries through substantial progressive reduction in agricultural support and protection. The spirit of the agreement was to develop the poor countries, which have wider agriculture base and thus reduce economic gap on the globe. Such agreement on agriculture was expected to have far reaching implications for different economics of the world as well for different regions of the country. It is high time to review the effects realized and visualized for different type of economies particularly India.

Therefore, in this paper an attempt has been made to view that what are the major provisions of this agreement. In respect of each provision, where do we stand or what has been our performance since it was affected and how we should adjust ourselves to the new world scenario?

**Market Access Commitment.** : It aims at substantial progressive reduction in protection to agricultural sector so as to prevent restrictions and distortions in the world trade. The overall tariff ( by converting non-tariff barriers such as quota, permit system, licensing system and special safe guard into tariff) is to be lowered by 36% in 6 years in developed countries, by 24% in 10 years in developing countries with a minimum cut of 15% and 10% per product line respectively . The least developed countries are not required to reduce such tariffs.

In India, different types of custom duties such as basic custom duty, additional custom duty, special additional duty including surcharge on agricultural commodities are siginificantly less than that of coressponding agreed final bound rate showing thereby that India has immediately reduced the tariff rates substantially ( Gulati *et.al.*). Certain agricultural products like rice, skimmed milk powder, maize, soybean etc. were bound during GATT negotiations at zero per cent or low tariff. India is bound to phase out quantitative restrictions upto April, 2001 on all commodities except for 632 commodities for reasons related to security, religion etc. Out of 673 major agricultural commodities, our tariff rates are far lower than the specified ones except in 8 commodities.

Rice, milk and milk products and various other agricultural commodities are highly protected in advanced countries like Japan, USA, EU, Canada etc. while in India tariff walls are very low. For example in Japan 700% protection is on rice and 557% on milk products. Canada has 213 % and 313% tariffs on milk products with <1.5% fat and >1.5% respectively. Therefore, either the tariff rates of other countries should also be lowered so that we can have access to the potential markets or we should raise our tariff walls as well and protect an economy for dumping . India is bound for agriculture tariff at 100% for raw commodities, 150% for processed agro-products and 300% for edible oils.

It was also provided in the agreement that sanitary and phyto- sanitary measures necessary to protect human, animal and plant life and health was specified in GATT Article xx(b) to be followed as per international specifications. Specicial safeguards (SSG) clause in agreement allows for additional tariffs in case of low import prices or sharply increased import volumes. Most of the developing countries do not have access to SSG , which needs to be taken up with WTO. Most of the advanced countries have taken this clause to shield themselves against the import from developing countries. Agricultural production is exposed to natural factors of rainfall, humidity, storms, temperature etc. The protection from damage by physical injury and by pests and diseases cannot be ensured to the tune of 100% . Hence rejection of anyone's produce even on the gate of importing countries is not difficult as per this clause. The most serious effect of this clause has been on trade of horticulture products and meat. Therefore, there is strong need to take up with WTO to specify the reasonable normal tolerance limits for different agriculture commodities.

**Subsidies.** The aggregate measure of domestic support (AMS) to agriculture is to be limited to a maximum of 5 % in developed and 10% of the value of production of individual product in developing countries. The AMS ( also called Amber Box) includes both non-product specific subsidies ( Subsidies on water, electricity, credit, fertilizers, seeds , pesticides, farm machinery etc) and product specific subsidies worked out on the basis of domestic price minus international price of the product. If the AMS exceeds the prescribed limit, the country is committed to reduce domestic support by 13.3% in case of developing countries over 10 years and by 20% in case of developed countries in 6 years.

1. AMS does not include measures having minimal impact on trade such as research, plant protection measures, infrastructure, public stock holding for food security , training and extension services, marketing and promotion, services, environmental programmes, decoupled income support, Govt. financial participation in income insurance to the farmers, structural adjustment programmes such as producer retirement, resource retirement and investment aids.
2. Blue Box measures representing direct payments under production limiting programmes.
3. Special and differential treatment for developing countries such as investment subsidies and agricultural input subsidies to low income and resource poor farmers. However, flaws in this clause are

a). Exemption of green box measures which cover a large variety of costs a discussed above provides escapism to the most protected economies.

b) There is no specific definition of a 'resource poor' farmer. A resources poor farmer of USA is much different than a resource poor farmer of India where three-fourth of the farmers have operational area of less than 5 acres. Further, the farmers in India are prone to high degree of risk and uncertainties due to high fluctuations in climatic factors and market forces. Poor countries cannot provide blue box support to their poor farmers making them still more incompetitive. Different economies based on relativity can have different set of criteria of resource poor and thus claim a large scale exemption. The green box and blue box measures are not transparent as they provide a cover to the developed countries to rechannelise AMS through such boxes have shown that the developed countries particularly U.S.A., E.U and Japan account for 87.5 per cent of the total green box expenditure of member countries.

c) The base period subsidies shown by most of the farsighted countries were on the higher side and thus lowering them would not have impact.

d) The working out of product specific support on the basis of International prices sound base prices which themselves are highly volatile, does not provide sound base for AMS . The difference between global prices and natural price due to devaluation of currency also requires clarification. If the the rules of the game are to be fair for all, the AMS should be fixed at some minimum and some maximum rather than first showing very high figure and then lowering by some percentage of it. Surprisingly, the nonproduct specific subsidies varied from 31.78% in 1990 to 69.31% in 1992 ( Gulati, 1999). Even to compensate the negative subsidies huge amount of financial support is required in agriculture sector, which is not possible for poor countries.

On the other hand, data presented in Table 1(a) indicates that support under green box policies was only ECU 9233.4 m in 1986-88 ( base year of agreement) which increased to ECU 22130.3 m in 1996. Similarly, in USA it was more than doubled during this period. The support under blue box policies was also enhanced. On the other hand non- product specific support was reduced both by EU and USA. Similarly, the AMS also declined from ECU 73645 m in 1986-88 to ECU 50752 m.

As observed from Table 2, out of 46 developing and 11 developed countries studied, the support under green box policies was claimed to the extent to 100% under research, 91% under pest control in developed countries as against 68% and 50% in developing countries . Likewise, in almost all the services the agriculture of developed countries claimed much higher support as compared to the developing ones. It is further evidenced by Table 3 that the developed countries accounted for 85.1% of the total green box support in 1995 while in the developing countries ( though having higher agrarian base and poor farmers) green box support was even less than 15% the total for the world as a whole . The share of developed countries in GB support further showed increase to 87.5 % in 1996.

**Export Subsidies :** The export subsidies were subjected to reduction commitment. The direct export subsidies are to be reduced by 36% in developed countries and quantity of subsidized export is to be lowered by 21%. The developing countries are to reduce export subsidies by 24% and the quantity of subsidized export by 14% within 10 years . It includes internal transport cost of marketing, export promotion etc.

The export subsidies not included here are export credit, export credit guarantee or insurance. The agreement on Agriculture allows only 25 countries to provide export subsidies. The export subsidies in case of wheat by USA, EU, Canada, Turkey and Hungry was 95% . The rice subsidy was 100% in case of Indonesia, Uruguay, EU, USA and Cambodia, in case of sugar and dairy products. EU was the major user of export subsidies. Even if the export subsidies are reduced by 36% , it still would be enormous to make others with these countries.

The agriculture surplus states like Punjab and Haryana are in the dire need of infrastructure for export which is part of green box policies but the Govt. due to financial constraints is unable to provide. Above all, the food security being the basic issue, minimum support price has to be provided to encourage producers and even the mandi charges and other taxes are levied on the exporters apart from normal marketing costs of storage , transportation etc. rather than providing them export subsidies. How can they compete with developed world? Therefore, India should support the view that export subsidies be eliminated .

**Table 1: Applied Import Tariffs on Agricultural Products**

| Item | Previous tariff | Revised tariff | Bound duty |
|---|---|---|---|
| Wheat | 0% | 50% | 100% |
| Rice | 0% | 70-80% | 70-80% |
| Grain sorghum | 0% | 50% | 80% |
| Millets | 0% | 50% | 70% |
| Arecanut | 35% | 100% | 100% |
| Apples | 35% | 50% | 50% |
| Tea | 15% | 35% | 150% |
| Coffee | 15% | 35% | 100-150% |
| Sugar | 40% | 60% | 150% |
| Edible oils | 15-35% | 15-45% | 45-300% |

* Plus a countervailing duty of Rs. 850/t.

**Table 1(a): Green Box, Blue Box, AMS and PSE Support Levels of EC and US**

| European Community (Million ECU) | Base Period (1986-88) | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|
| Green Box | 9,233.4 | 18,779.2 | 22,130.3 | | |
| Blue Box | - | 20,843.5 | 21,520.8 | | |
| AMS product specific support including de minimis | 73,644.9 | 49,823.4 | 50,751.5 | | |
| Non-product specific support | - | 776.7 | 728.4 | | |
| Total (green box, blue box, de minimis and AMS) | 82,878.3 | 90,222.8 | 95,131 | | |
| PSE (Million ECU) | 90,392 | 83,442 | 74,970 | 96,729 | 116,075 |
| PSE (Million US$) | 99,619 | 94,605 | 85,000 | 109,670 | 129,808 |
| United States (Million $) | | | | | |
| Green Box | 24,098 | 46,041 | 51,825 | 51,249 | |
| Blue Box | - | 7,030 | - | - | |
| AMS product specific supports including de minimis | 24,659 | 6,310.87 | 5,867.84 | 6,474.66 | |
| Non-product specific AMS supports | 901 | 1,386 | 1,115 | 568 | |
| Total (green box,blue box,de minimis and AMS) | 49,658 | 60767.87 | 58,807.8 | 58291.66 | |
| PSE (Million $) | 41,428 | 15,205 | 23,500 | 30,616 | 46,960 |

Sources: OECD in Figures, 1999, 'Domestic Support', AIE/S2/Rev.2,34 September, 1999, OECD in Figures, 1996.

**Table 2: Usage of Green Box Subsidies (Per cent of countries claiming measure)**

| Measure | Developing (46) | Developed 11 |
|---|---|---|
| **General Services** | | |
| Research | 68 | 100 |
| Pest and disease control | 50 | 91 |
| Training Services | 43 | 55 |
| Extension and advisory services | 59 | 91 |
| Inspection services | 30 | 73 |
| Marketing and promotion services | 41 | 64 |
| Infrastructural services | 52 | 55 |
| General Services (not specified) | 28 | 45 |
| **Direct payment to producers** | | |
| Decoupled income support | 4 | 27 |
| Income insurance and income safety-net programmes | 9 | 27 |
| Crop insurance for natural disasters | 24 | 91 |
| Structural adjustment assistance provided through producer retirement programmes | 2 | 27 |
| Structural adjustment assistance provided through resource retirement programmes | 2 | 45 |
| Structural adjustment assistance provided through investment aids | 15 | 64 |
| Environmental programmes | 30 | 45 |
| Regional assistance programmes | 20 | 36 |
| Others (not specified) | 20 | 27 |
| Public stock holding for food security purposes | 17 | 45 |
| Domestic food aid | 15 | 27 |

Source: WTO, Supporting tables relating to commitments on agricultural products in part IV of the Schedules, G/AG/AGST/Vols 1-3. WTO, Geneva cited in Greenfield and Kanandreas 1996. Food Policy Vol 21 'Uruguary Round Commitments on Domestic Support: their implications for developing countries.

**Table 3: Total Expenditure on Green Box (GB) measures, 1995-96**

| Country | 1995 | | 1996 | |
|---|---|---|---|---|
| | Amount (US$) million | Share in reported GB expen-diture of all members | Amount (US$ million) | Share in reported GB expen-diture of all members |
| Grand total of reported expenditure | 129,440 | 100.0 | 126,735 | 100.00 |
| Total of reporting developed countries | 110,173 | 85.1 | 110,958 | 87.5 |
| Total of reporting developing countries | 19,266 | 14.9 | 15,776 | 12.5 |

Source: WTO, Supporting tables relating to commitments on agricultural products in part IV of the Schedules, G/AG/AGST/Vols 1-3. WTO, Geneva cited in Greenfield and Kanandreas 1996. Food Policy Vol 21 'Uruguary Round Commitments on Domestic Support : their implications for developing countries.

**Trade Related Intellectual Property Rights ( Trips) :** It provides norms for copyrights, trademarks, geographical indication, design patents etc. A number of international agreements on most of these rights already exist. On patents, the basic obligation is that of product and process patent in all areas including agriculture. On plant varieties, there is a provision of protection by patents or by *sui generis system.* India has opted for *sui generis system* which is being developed taking into account the national requirements. Though it is still in the process but the common feeling of charging high price of seed of new varieties of plants and breeds of animals by the multinational corporations (MNCs) is being taken care of. There would be none to thrust new technology upon farmers. They are free to multiply, exchange and sell the produce but can not commercially sell as seed. The buyers of technology need to examine throughly the added cost and added return by the way of new technology need to examine thoroughly the added cost and added return by way of new technology before taking such decisions.

We are still in the process to give final shape to legislation pertaining to patenting in agriculture even after 5 years of signing the agreement.

**Social Clause. :** An after –thought of developed countries was to introduce 'Social clasue' in GATT treaty. This clause aimed at nullifying the price advantage enjoyed by the developing countries like India due to low labour cost. Such goods thus would be subject to import duties by the developed economies. As a result of this:

a) The developing countries forefeit the competitive edge over advanced countries.
b) The multinational firms interested to make investment in developing countries may find it unattractive as a result of this clause.
c) The migration of labour to advanced countries may be checked resulting in still higher rate of unemployment and misery of developing economics.
d) The child labour which forms an important part of working population in some specialized enterprises like carpet industry is supposed to be taken out causing severe effect on such industries.

The clause has yet been kept out of the agreement and India has opposed it along with most of other developing nations.

**Visualized Impact of WTO**

A coalition of 11 less developed states has recently submitted to the WTO accusing the EU and USA of throwing up new barriers to produce from poorer natives despite pledges in 1994 to open markets while the big powers had been allowed to continue subsidies that helped their farmers to maintain or increase exports. The accusations are supported with facts presented in the enclosed tables. The agricultural products constituted 44.24% of total exports of India in 1960-61. It has gone down to 19.41% in 1990-91and 14.19% in 2000-01.

Food security is the most important element on which social and political stability of the poor countries depends . In such countries , production is encouraged generally through price support policies but now dumping of food and food products in the developing countries has created a sense of insecurity among the farmers . This happned in case of wheat and skimmed milk powder, which entered the country to the tune of 1.5 mt. and 18000 tonnes respectively in 1999 giving a severe hit to the domestic production sector. At the time when the GATT agreement was signed, it was considered as ray of hope for the developing countries because the highly protected economies were expected to open up resulting in increase in prices in the international markets, thus befitting the agriculture based economies. But the reality is far from this analogy because of the following aspects.

Therefore, on the basis of the above discussion, it is clear that the fulfillment of basic objectives of the WTO is not insight. No significant increase in world trade in agriculture has taken place despite this agreement. Trade of India and other developing countries has rather shown one negative picture due to decline in price of agricultural products. It was expected that cereal production would shift to developing countries due to comparative advantage but it is getting reverse order. The loopholes like green box and blue box policies and other manipulations made by developed countries and lack of our preparedness to meet the challenge appear to damage our interest . All these factors are creating problems for the developing countries to have access to the market of developed countries . Therefore, the developing countries should be allowed to raise tariff so as to protect their producers and the developed countries should lower the tariff and encourage more free trade. Further, the dumping has to be curtailed through effective anti-dumping measures so as to hit the internal industries of the developing countries.

**Sustainability of Agriculture in High Potential Areas**

After independence, the country was engulfed into serious food shortages and thus had to import food grains worth heavy foreign exchange . The high potential area of the country such as Punjab, Haryana and part of the Uttar Pradesh made significant contribution to the food security of the country, which not only relieved the country from clutches of the food problem but also generated exportable surpluses. In the context of World Trade Organization, which envisages reduction in tariff barriers, domestic support and export subsidies, apart from sanitary and phyto- sanitary measures , both challenges and opportunities have come up. On the other hand, the high potential areas have faced the environmental problems of depletion of water resource and soil fertility , eroding bio-diversity, developing pest resistance etc, threatening the sustainability of existing farming systems. It has been emphasized that diversification of agriculture is to be brought about from rice- wheat to fruits, vegetables, dairy farming etc. All this requires:

1. The production of agricultural commodities over and above the domestic needs has to be viewed from the **market requirements not only within the country but also the world market.**
2. Though the agriculture is competitive when compared with in the main producing countries in terms of **cost of production but the marketing and handling charges** are so high that by the time it reaches the consuming centre, the entire comparative advantage is lost. The cost of freight market charges, local support and handling need to be subsidized especially for export purposes.
3. The Punjab state has vast production potential of fruits, vegetables, floriculture, meat , milk, fish, spices, forestry, basmati, cotton, mushrooms etc. There is need for setting up of **dry port with integrated cargo handling cold storage and refrigerated transport** in the state for export of such perishable products.
4. For better market outlook of different consuming and producing countries, a marketing cell needs to be created which should make **the information available to the exporters quickly.**
5. **Technical know-how regarding production, processing and marketing of exportable goods** should be provided by the Govt.

6. In spite of increasing opportunity for export of agricultural products, there is increasing stress on sanitary and phyto-sanitary measures to protect human, animal and plant health. **Quality consciousness requires strict legislation and improved processing and package facilities. Strengthening of quality control including adoption of quality systems such as ISO 9000/HACCP for export units and establishment of heat treatment facilities for elimination of pest incubation for products** are required in order to gain better access to the overseas markets.
7. The farmers in general being small and marginal are unable to take up high investment and export of their products. In the first instance, the most **successful primary cooperative societies** may be entrusted this job.
8. Quick action by the govt. in **enacting IPR acts** in agriculture is urgently required.

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## The question of nutritional enigma of mountain lands and up gradation of the productivity of crops in Western Himalayan ecosystem, India

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### ABSTRACT

In mountain lands of Western Himalayas in India; and the fact that such lands are acidic in character; the 'nutritional enigma' in respect of the deficiency of major nutrients such as phosphorus, sulphur, calcium and magnesium *vis-à-vis* micronutrients viz., molybdenum, boron and iodine is a notorious barrier in realizing the full potential of crop productivity besides the toxicity of certain other elements namely aluminum, iron, zinc and copper. The total area of such lands in the region is about 0.10 to 0.15 million hectares that support the food crops, pulses, oil seeds and vegetables. The sustainable development of agriculture in mountain lands of Western Himalayas can be attained by adopting better soil fertility management skills that would lead directly to the improvement of the livelihoods of mountain people and their environment. The mountain lands are difficult to access for interventions due to which the efficient fertilization is lacking for want of scientific knowledge and the poor economic conditions of the farmers. This has given a kind of nutritional imbalance which is one of the key factors identified for low productivity in the region. This paper highlights the information on the positive response to the application of some important nutrients viz., phosphorus, sulphur, lime, molybdenum and organics by different crops. Some compiled information suggested in the present paper ensures that reasonable benefits derived from appropriate nutrient application contribute directly to the upgradation of livelihood of mountain people manifested in comparative advantages of mountain areas for the production of specific crops. The promotion of sustainable mountain farming systems, including locally sustainable measures for the adoption of traditional and improved technologies for soil nutrients and fertility management have also been emphasized upon.

Some successful endeavors of such interventions having been made in terms of winning over the nutritional enigma in respect of phosphorus, sulphur, molybdenum and lime vis-a-vis organics in variety of crops have been documented here. For example; an application of phosphorus @30 kg $P_2O_5$/ha along with 10 t FYM/ha significantly improved the rhizome yield of turmeric and quality in terms of protein and curcumin content. In chilli, onion and lentil crops, phosphorus management showed an improvement in the productivity and P uptake of these crops. Spectacular response to the application of phosphorus in the presence and absence of organic manure showed an increase in the productivity of wheat grain to the tune of 49 to 142 per cent over control. Similarly, phosphorus nutrition of potato tubers demonstrated that the concomitant increase in phosphorus application ranging from 22 to 66 kg P/ha, upgraded the productivity of potato tubers from 25 to 41 per cent. Likewise, an application of sulphur has also increased the yield of chilli, onion and toria. Furthermore, an application of molybdenum either through soil or through seed increased the yield as well as uptake of Mo by soybean grains. This also resulted in a significant increase in the protein content of soybean grain. Under acid soil conditions, application of 250 g Mo as sodium molybdate/ha resulted in substantial increase in the productivity of cauliflower. The effect of lime on the productivity of wheat, soybean and linseed crops revealed that with each increment of lime up to 3.7 t/ha, a significant increase in productivity of these crops was discernible demonstrating, thereby, the beneficial effect of liming. Further, studies on the integrated nutrient management in wheat, potato and peas demonstrated that with the combined application of organic and inorganic fertilizer, one can save 33 per cent inorganic fertilizer with the addition of organic @ 10 t/ha.

**Introduction**

In India, acidic lands constitute about 49 million ha; out of the total of 157 million ha which are spread in the states of Himachal Pradesh, Haryana (Mornihills), Sikkim, Tripura, Misoram, Tamilnadu and parts of Karnataka and Jammu and Kashmir besides coastal areas of the country. So far as the Western Himalayan region in Himachal Pradesh in mountain perspective is concerned, the total area is about 55.7 thousand square kilometre yet, the cultivation is performed in 10-15 per cent area constituting about 0.10 to 0.15 million hectares under acidic lands that support the principal food crops, pulses, oil seeds, vegetables and fruits for the nutritional security of farmers who, by and large, are small and marginal constituting about 85 per cent of the population. However, the productivity of crops is poor; wheat (1.5 t/ha), rice (2.0 t/ha), oilseeds (0.5 t/ha) and pulses (0.7 t/ha) and

The low productivity of crops on such lands is due to the fact that these lands encompass a unique "nutritional enigma" in the shape of deficiency or toxicity of nutrients in soils and crops. Besides, an imbalanced nutrition is also one of the reasons; under which an average consumption of $N+P_2O_5+K_2O$ is about 40 kg/ha while the annual (NPK) requirement of the crops is around 240 kg/ha, in rice-wheat system. Under such a nutritional enigma, the phosphorus hunger and its poor availability to crops because of high P fixation, high P buffer power, culminating into high P requirements of crops under acidic soil conditions is the dominant one. The soil factors for low P availability are low pH and the high amount of P fixation components such as active forms of Al, Fe, Mn besides clay. Consequently, the phosphorus management is the key issue for realizing sustainable yield of crops. The other nutrients that show low availability from soil system to plant system on such lands are sulphur, molybdenum, boron, iodine, calcium and magnesium for sustainable food production. On the other hand, some of the nutrients that show toxicity are Al, Fe, Mn and Zn. The other physical factors that influence adversely the healthy crop productivity are low soil temperatures in winter inhibiting good germination, good root proliferation, good shoot system and finally good crop production. The problem of clod formation following rice harvest and their serving as barrier to germination of wheat seeds besides creating disturbances in air, water and nutritional management for this crop is another enigma for poor productivity.

But, by and large, the mountain lands have responded favourably in many crops and soils to the application of inorganics such as phosphorus, sulphur, lime, molybdenum and to organics such as farm yard manure and poultry manure. Consequently an effort has been made in this paper to highlight the ameliorative efforts that have, hitherto, been made to win over the nutritional enigma in respect of some crops in relation to these nutrients having been applied through inorganics and organics.

**Phosphorus**

Sharma *et al.*, (2002) during their field experimentation studies, with different treatments in the presence and absence of phosphorus besides FYM application on turmeric, demonstrated that the application of phosphorus @ 30kg $P_2O_5$/ha over no phosphorus significantly improved the average rhizome yield of turmeric, which was to the tune of 56 per cent (Table 1). However, the increase in rhizome productivity of turmeric due to 10 t FYM/ha over no FYM treatment was significant to the tune of 22 perc ent. Phosphorus and FYM caused significant improvement in the quality of turmeric rhizomes in terms of the protein and curcumin content (Table 2 & 3). It was 34 and 17 per cent due to phosphorus @ 30 kg $P_2O_5$ over no P, whereas 15 and 7 per cent due to FYM, over control respectively. By applying 1.0 kg of $P_2O_5$/ha; one can obtain turmeric rhizome yield of 125 kg, with a VCR of 19:1 and B:C ratio of 18:1 with an economic ramifications that by spending one rupee on $P_2O_5$ through single super phosphate; one can earn an economic yield advantage of rupees 19 in respect of VCR and rupees 18 in respect of benefit cost ratio (Table 4).

**Table 1. Effects of phosphorous and FYM on the Productivity of Turmeric rhizomes in mountain acid soils of western Himalayas.**

| Sr.No. | Treatments | Productivity (q/ha) | | |
|---|---|---|---|---|
| | | 1999 | 2000 | Average |
| 1 | Absolute control | 51.13 | 48.00 | 49.57 |
| 2 | FYM @ 10 t/ha | 62.40 | 58.33 | 60.37 |
| 3 | FYM @ 10 t/ha +100 % $NP_0k$ | 69.40 | 63.7 | 66.53 |
| 4 | FYM @ 10 t/ha +100 % NPk | 98.00 | 110.07 | 104.03 |
| | LSD (0.05) | 7.37 | 2.65 | 3.81 |

Source: Sharma *et al* (2002)

**Table 2. Effects of phosphorous and FYM on the protein content in turmeric in mountain acid soils of western Himalayas.**

| Sr.No. | Treatments | Protein (%) | | |
|---|---|---|---|---|
| | | 1999 | 2000 | Average |
| 1 | Absolute control | 5.37 | 5.78 | 5.58 |
| 2 | FYM @ 10 t/ha | 6.18 | 6.63 | 6.41 |
| 3 | FYM @ 10 t/ha +100 % $NP_0k$ | 7.49 | 8.16 | 7.83 |
| 4 | FYM @ 10 t/ha +100 % NPk | 10.42 | 10.50 | 10.46 |
| | LSD (0.05) | 0.38 | 0.39 | 0.27 |

Source: Sharma *et al* (2002)

**Table 3. Effects of phosphorous and FYM on curcumin content in turmeric mountain acid soils of western Himalayas.**

| Sr.No. | Treatments | Curcumin (%) | | |
|---|---|---|---|---|
| | | 1999 | 2000 | Average |
| 1 | Absolute control | 2.08 | 2.16 | 2.12 |
| 2 | FYM @ 10 t/ha | 2.19 | 2.32 | 2.26 |
| 3 | FYM @ 10 t/ha +100 % $NP_0k$ | 2.37 | 2.47 | 2.42 |
| 4 | FYM @ 10 t/ha +100 % NPk | 2.80 | 2.88 | 2.84 |
| | LSD | 0.17 | 0.18 | 0.12 |

Source: Sharma *et al* (2002)

**Table 4. Average effects of phosphorus and FYM on additional productivity, response yard stick, benefit cost ratio and value cost ratio (VCR) in turmeric (Average 1999-2000)**

| | | | | |
|---|---|---|---|---|
| a | Yield in Control(q/ha) | | | 49.57 |
| b | Yield in FYM (q/ha) | | | 60.37 |
| c | Additional Productivity due to $FYM_{10}$ over control (q/ha) | | | 10.80 |
| d | Percent increase due to $FYM_{10}$ over control | | | 22.00 |
| e | Yield due to 100% $NP_0K$ ($N_{60}$ $P_0$ $K_{30}$) (q/ha) | | | 66.53 |
| f | Yield due to 100% NPK ($N_{60}$ $P_{30}$ $K_{60}$) (q/ha) | | | 104.03 |
| g | Additional productivity due to $P_{30}$ over $P_0$ (q/ha) | | | 37.50 |
| h | Percent increase due to $P_{30}$ | | | 56.40 |
| i | Response yard stick (Kg Rhizome per Kg ($P_2O_5$) | | | 125.00 |
| j | Value cost ratio (VCR) | | | 19:1 |
| k | Benefit cost ratio (B/C Ratio) | | | 18:1 |
| | | N | $P_2O_5$ | $K_2O$ |
| i) | 100% NPK (kg/ha) | 60 | 30 | 60 |
| ii) | Price per kg (Rs) | 10.0 | 18.6 | 7.1 |
| iii) | Price/Kg turmeric (Rs) | 8.0 | | |

Source: Sharma *et al* (2002)

In an experiment conducted on acidic mountain lands of Western Himalayas on the management of phosphorus in chilli (Bhardwaj, 2002), revealed that the highest dry chilli yield (7.1 q/ha) and Puptake 12. 3 kg/ha was obtained with 75 kg $P_2O_5$/ha (Table 5 & 6). In an another experiment by the same worker on phosphorus management in onion; it was demonstrated that the onion bulb yield increased with increasing level of P and application of phosphorus @ 100 kg $P_2O_5$/ha produced the highest yield of onion 203.8 q/ha which was 82 per cent higher (Table 7) than control (112.3 q/ha). Effect of different phosphorus doses were studied in lentil crop which revealed that the grain productivity of lentil increased with increasing P application (Table 8). The highest grain yield 13.2 q/ha was obtained with 60 kg $P_2O_5$/ha; which was 47 per cent higher than control (8.9 q/ha). The phosphorus uptake pattern was similar to that of grain yield.

**Table 5. Effect of phosphorus and sulphur on dry Chilli yield (q/ha) Kharif 2001.**

| Sulphur levels | $P_2O_5$ levels (kg/ha) | | | | |
|---|---|---|---|---|---|
| (kg/ha) | 0 | 50 | 75 | 100 | Mean |
| 0 | 3.2 | 4.3 | 5.2 | 6.6 | 4.8 |
| 25 | 3.5 | 6.1 | 6.6 | 6.9 | 5.8 |
| 50 | 5.8 | 6.4 | 7.1 | 6.5 | 6.4 |
| Mean | 4.1 | 5.6 | 6.3 | 6.7 | |
| LSD (0.05) | P=0.17 | S=0.15 | PxS=0.30 | | |

Source: Bhardwaj (2002)

**Table 6. Effect of phosphorus and sulphur on P uptake (kg/ha)by chilli Rabi - 2001-2002.**

| Sulphur levels | $P_2O_5$ levels (kg/ha) | | | | |
|---|---|---|---|---|---|
| (kg/ha) | 0 | 50 | 75 | 100 | Mean |
| 0 | 5.5 | 8.0 | 9.2 | 11.4 | 8.5 |
| 25 | 5.8 | 9.7 | 10.9 | 12.1 | 9.6 |
| 50 | 8.1 | 10.6 | 12.3 | 12.2 | 10.8 |
| Mean | 6.5 | 9.4 | 10.8 | 11.9 | |
| LSD (0.05) | P=0.52 | S=0.46 | PxS=0.30 | | |

Source: Bhardwaj (2002)

**Table 7. Effect of phosphorus and sulphur on dry onion bulb yield (q/ha) Rabi - 2001-2002.**

| Sulphur levels | $P_2O_5$ levels (kg/ha) | | | | |
|---|---|---|---|---|---|
| (kg/ha) | 0 | 50 | 75 | 100 | Mean |
| 0 | 112.3 | 139.0 | 162.3 | 171.3 | 146.2 |
| 25 | 147.0 | 164.7 | 180.0 | 210.0 | 175.4 |
| 50 | 158.3 | 178.7 | 211.0 | 230.0 | 195.5 |
| Mean | 139.2 | 160.8 | 184.4 | 203.4 | |
| LSD (0.05) | P=5.5 | S=4.9 | PxS=8.9 | | |

Source: Bhardwaj (2002)

**Table 8. Effect of phosphorus and sulphur on S uptake and lentil yield (q/ha) Rabi, 2001- 2002.**

| Sulphur levels | $P_2O_5$ levels (kg/ha) | | | | |
|---|---|---|---|---|---|
| (kg/ha) | 0 | 0 | 20 | 40 | Mean |
| 0 | 7.2 | 9.2 | 10.1 | 10.5 | 9.3 |
| 25 | 9.5 | 10.6 | 12.7 | 14.4 | 11.8 |
| 50 | 10.0 | 11.3 | 13.1 | 14.4 | 12.2 |
| Mean | 8.9 | 10.4 | 12.0 | 13.1 | |
| LSD (0.05) | P=0.24 | | S=0.21 | PxS=0.41 | |

Source: Bhardwaj (2002)

In an another experiment (Sharma, 2001), the effect of compacted rock phosphate products was studied on lentil grain yield and P uptake which revealed that maximum grain yield of lentil 14.5 q/ha was recorded in treatment where phosphorus was applied through single super phosphate @ 60 kg $P_2O_5$/ha followed by compacted rock phosphate product JPRB+MAP+S (12.8 q/ha) as given in Table 9. The same was true for P uptake parameter.

**Table 9. Effect of compacted Rajphos products on lentil grain yields and P-uptake.**

| Treatment | Grain Yield (q/ha) | P-uptake (kg.ha) |
|---|---|---|
| N and K only | 6.1 | 7.1 |
| JPR (A) | 8.1 | 7.8 |
| JPR (A)+MAP | 10.6 | 8.7 |
| JPR (A) +SSP | 11.6 | 11.2 |
| JPR (A) +MAP+S | 12.7 | 12.1 |
| JPR (B) | 8.6 | 7.7 |
| JPR (A)+MAP | 10.35 | 9.8 |
| JPR (A) +SSP | 11.1 | 11.7 |
| JPR (A) +MAP+S | 12.8 | 13.6 |
| SSP | 14.5 | 15.4 |
| LSD (0.05) | 0.9 | 1.2 |

Source: Sharma (2001)

The experiments having been conducted by Gupta and Sharma (1987) reported specticular response to the application of phosphorus in the presence and absence of organic manures (Table 10). It was discernable that application of phosphorus ranging from 30 to 180 kg $P_2O_5$/ha brought out an increase in the productivity of wheat grains to the tune of 49 to 142% over control, respectively averaged over FYM. The application of FYM @ 8 t/ha further improved the productivity by 35% averaged over P levels. Furthermore, the quadratic response studies of wheat productivity in relation to phosphorus and FYM gave an optimum dose of phosphorus to the tune of 96.18 kg $P_2O_5$/ha with an economic grain productivity of 3.03 t/ha in the absence of FYM with a profit of Rs. 4530/ha. However, in the presence of 8 t/ha FYM the optimum dose of phosphorus came out 90.25 kg $P_2O_5$/ha with an economic grain productivity of 3.87 t/ha with a profit of Rs. 4692/ha (Table 11).

**Table 10. Effect of phosphorus and organic manure in improving the productivity of wheat (S-308) on a mountain alfisol from Mid-West Himalayas**

| Effect of P levels ($P_2O_5$ kg /ha) | Grain productivity (kg /ha) | Per cent increase |
|---|---|---|
| 0 | 1718 | - |
| 30 | 2558 | 49 |
| 60 | 2943 | 71 |
| 90 | 3511 | 104 |
| 120 | 3802 | 121 |
| 150 | 4033 | 135 |
| 180 | 4160 | 142 |
| LSD (0.05) | 330 | - |
| **Effect of FYM** | | |
| No Farm Yard Manure | 2769 | - |
| Farm yard Manure (8 t/ha) | 3729 | 35 |
| LSD (0.05) | 199 | - |

Gupta and Sharma (1987)

**Table 11.Quadratic response of wheat grain productivity in relation to phosphorus and Farm yard manure application**

| Treatment | Optimum dose of Phosphorus ($P_2O_5$ kg/ha) | Economic grain productivity (t/ha) | Profit(Rs/ha) |
|---|---|---|---|
| Phosphorus in the absence of FYM | 96.18 | 3.03 | 3930 |
| Phosphorus in the presence of 8 t /ha FYM | 90.25 | 3.87 | 4692 |

Gupta and Sharma (1987)

Sood (1996), while working on the phosphorus nutrition of potato tubers in the mountain land of Shimla, Himachal Pradesh, India; demonstrated that the concomitant increase in phosphorus application ranging from 22 to 66 kg P /ha, upgraded the productivity of potato tubers from 25 to 41 per cent (Table 12) meaning, thereby, that P is very essential to tuber productivity in mountain lands both for seed and table purposes.

**Table 12. Effect of phosphorus on the productivity of potato on a mountain land Shimla, Himachal Pradesh-India (Year- 1989)**

| P level (kg/ha) | Tuber yield (t/ha) | % increase |
|---|---|---|
| 0 | 22.3 | - |
| 22 | 27.9 | 25 |
| 44 | 29.9 | 34 |
| 66 | 31.5 | 41 |
| LSD (P= 0.05) | 3.6 | - |

Sood (1996)

**Sulphur**

Response of different levels of sulphur in chilli crop (Bhardwaj, 2002) demonstrated that application of 50 kg S/ha recorded highest yield of chilli (6.4 q/ha) as presented in Table 5, 6 and 7 respectively. There was a significant increase in total sulphur content in chilli with increase in sulphur levels and the maximum sulphur uptake (12.2 kg S/ha) was noted with an application of 50 kg S/ha. Studies on sulphur nutrition of onion showed that its application @ 50 kg S/ha produced maximum onion bulb yield 194.5 q/ha which was 73 per cent higher over no sulphur application.

**Molybdenum**

In mountain acidic lands, Sharma *et al.,* (1985) studied the response of applied Mo on soybean in acidic lands and observed a significant increase in grain yield and molybdenum uptake by soybean grains with increasing doses of applied molybdenum (Table 13 and 14). The study further revealed that Mo response could be obtained at available soil Mo levels ranging from 0.025 -0.290 ppm. The results further revealed that in most of the acidic land under study the interaction of soil factors viz., pH, low available, total molybdenum and soil texture may be the contributing factors to yield response of soybean to applied molybdenum.

**Table 13. Uptake of molybdenum by soybean grains as affected by Mo doses.**

| Soil | Treatment | | | | | |
|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 | Mean |
| Jogindernagar | 1.72 | 5.05 | 9.48 | 9.14 | 7.93 | 6.67 |
| Katrain | 1.36 | 3.59 | 5.49 | 5.55 | 7.62 | 4.72 |
| Ahju | 0.57 | 0.42 | 4.36 | 3.83 | 8.73 | 3.98 |
| Bhadhairkhar | 0.72 | 0.90 | 1.06 | 0.93 | 2.45 | 1.22 |
| Andretta | 0.23 | 0.53 | 0.96 | 0.63 | 1.60 | 0.79 |
| Palampur (COA) Farm | 0.12 | 0.42 | 0.36 | 0.26 | 0.52 | 0.33 |
| Nurpur | 1.08 | 3.16 | 7.69 | 8.11 | 11.2 | 6.25 |
| Shahpur | 0.20 | 2.74 | 1.07 | 2.08 | 1.61 | 1.55 |
| Samloti | 0.89 | 1.79 | 0.88 | 1.39 | 2.31 | 1.45 |
| Bhawarna | 1.97 | 2.90 | 6.56 | 5.46 | 7.49 | 4.87 |
| Arla | 0.81 | 5.54 | 4.40 | 6.20 | 6.74 | 4.75 |
| Bhatoo | 3.41 | 1.46 | 2.47 | 2.88 | 4.38 | 2.92 |
| Chimbalhar | 1.62 | 2.10 | 3.43 | 2.57 | 4.83 | 2.91 |
| Dadh | 1.40 | 2.59 | 5.16 | 4.56 | 6.90 | 4.12 |
| Gopalpur | 0.13 | 0.72 | 1.41 | 1.42 | 2.11 | 1.16 |
| Mean | 1.08 | 2.39 | 3.65 | 3.67 | 5.10 | |
| CD value | (0.05) | | | (0.01) | | |
| Treatments | 0.60 | | | 0.79 | | |
| Soil | 1.04 | | | 1.37 | | |
| Interaction (treatments x soil) | 2.34 | | | 3.08 | | |

Source: Sharma *et al.*(1985)

**Table 14. Effect of molybdenum doses on soybean grain yield.**

| Soil | Treatment | | | | | |
|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 | Mean |
| Jogindernagar | 10.87 | 9.72 | 13.60 | 12.44 | 10.53 | 11.43 |
| Katrain | 11.90 | 12.60 | 14.22 | 13.66 | 12.90 | 13.06 |
| Ahju | 5.24 | 11.87 | 15.03 | 10.84 | 11.47 | 10.89 |
| Bhadhairkhar | 12.02 | 12.69 | 12.45 | 11.00 | 11.30 | 11.69 |
| Andretta | 10.94 | 11.19 | 12.92 | 8.87 | 10.82 | 10.94 |
| Palampur (COA) Farm | 4.72 | 7.14 | 4.17 | 4.31 | 4.45 | 5.08 |
| Nurpur | 11.45 | 6.88 | 10.47 | 11.66 | 10.92 | 10.21 |
| Shahpur | 6.99 | 11.63 | 9.60 | 10.49 | 9.30 | 9.60 |
| Samloti | 9.09 | 10.22 | 10.24 | 6.56 | 9.53 | 9.13 |
| Bhawarna | 8.46 | 12.22 | 14.68 | 12.40 | 12.59 | 12.07 |
| Arla | 11.50 | 13.06 | 11.62 | 12.79 | 9.92 | 11.79 |
| Bhatoo | 8.67 | 8.01 | 9.55 | 10.43 | 10.63 | 9.45 |
| Chimbalhar | 10.24 | 10.67 | 11.60 | 11.23 | 12.12 | 11.19 |
| Dadh | 11.49 | 12.02 | 11.63 | 10.99 | 11.89 | 11.60 |
| Gopalpur | 3.50 | 8.54 | 16.88 | 10.49 | 13.62 | 10.61 |
| Mean | 09.13 | 10.50 | 11.94 | 10.55 | 10.81 | |
| CD value | | (0.05) | | (0.01) | | |
| Treatments | | 1.12 | | 1.47 | | |
| Soil | | 1.94 | | 2.55 | | |
| Interaction (treatments × soil) | | 4.35 | | 5.71 | | |

Source: Sharma *et al.* (1985)

In an another experiment, the effect of Mo application on the yield and uptake by soybean were studied (Sharma and Minhas, 1986). The results indicated that the application of Mo either though soil or through seed increased the yield of soybean as well as uptake of Mo by grains (Table 15). Seed application was more effective than soil application in increasing the Mo uptake by grains. The Mo application also resulted in a significant increase in nitrogen and consequently, the protein content of soybean grains. Sharma *et al.*, (1988), in a field experiment concluded that the application of low levels of Mo (250 g as sodium molybdate/ha) applied as soil or spray application resulted in substantial increase in cauliflower curd yield in acid soil conditions (Table 16).

**Table 15. Effect of molybdenum application on the grain yield and Mo uptake by soybean grains**

| Treatment | Yield (q/ha) | | Mo uptake (g/ha) | |
|---|---|---|---|---|
| | 1981 | 1982 | 1981 | 1982 |
| $S_1T_1$ | 22.8 | 18.6 | 0.06 | 0.21 |
| $S_1T_2$ | 27.8 | 17.7 | 0.07 | 0.23 |
| $S_1T_3$ | 24.4 | 21.8 | 0.07 | 0.29 |
| $S_1T_4$ | 28.5 | 26.7 | 0.17 | 0.29 |
| $S_1T_5$ | 26.3 | 24.1 | 0.35 | 0.31 |
| $S_2T_1$ | 20.6 | 15.5 | 0.10 | 0.15 |
| $S_2T_2$ | 31.8 | 19.5 | 0.35 | 0.27 |
| $S_2T_3$ | 29.7 | 18.4 | 0.38 | 0.48 |
| $S_2T_4$ | 29.6 | 19.3 | 0.74 | 0.61 |
| $S_2T_5$ | 25.7 | 19.5 | 0.81 | 0.71 |
| CD (0.05) | 4.52 | 3.22 | 0.101 | 0.19 |

Source: Sharma and Minhas (1986)

**Table 16. Effect of molybdenum on yield attributes and yield of cauliflower curds.**

| Treatments | Total Weight of plants with roots (kg/pot) | Number of leaves/pot | Weight of stem (g/pot) | Weight of leaves +curd (kg/pot) | Marketable Cauliflower curd yield (q/ha) |
|---|---|---|---|---|---|
| Control (Recommended dose of NPK) (For soil application) | 26.7 | 515 | 463 | 20.6 | 133.7 |
| 250 g Sodium molybdate/ha (Soil application) | 31.3 | 534 | 513 | 31.5 | 213.7 |
| 500 g Sodium molybdate/ha (Soil application) | 36.5 | 679 | 699 | 35.7 | 216.4 |

Contd.

| | | | | | |
|---|---|---|---|---|---|
| 1000 g Sodium molybdate/ha (Soil application) | 35.6 | 695 | 624 | 33.3 | 203.7 |
| Control (for spray application) | 24.4 | 553 | 360 | 22.4 | 154.0 |
| 250 g Sodium molybdate/ha (Spray) | 37.9 | 589 | 546 | 30.5 | 255.0 |
| 500 g Sodium molybdate/ha (Spray) | 33.2 | 608 | 606 | 36.8 | 189.7 |
| 1000 g Sodium molybdate/ha (Spray) | 32.1 | 573 | 567 | 31.5 | 188.7 |
| LSD (0.05) | NS | NS | 123 | 7.9 | 44.4 |

Source : Sharma *et al.*(1988)

**Lime**

The experiment on the effect of lime on productivity of wheat, soybean and linseed crops was conducted on acidic mountain lands of Western Himalayas (Dixit and Sharma, 1993). The results revealed that with each increment of lime up to 3.7 t/ha significantly increased the productivity of all the three crops (Table 17). The increase in yield may be due to beneficial effect of liming in reducing the acidity and solubility of different forms of Al and Fe vis-a-vis increasing the microbial activity and ultimately, the productivity.

**Table 17. Effect of lime on grain yield of crops (q/ha)**

| Lime(tones/ha) | Wheat | Soybean | Linseed |
|---|---|---|---|
| 0 | 22.4 | 15.0 | 8.1 |
| 1.85 | 27.9 | 20.4 | 10.2 |
| 3.70 | 32.1 | 23.4 | 12.2 |
| 7.40 | 33.4 | 24.9 | 13.4 |
| LSD (0.05) | 2.1 | 1.5 | 1.4 |

Source: Dixit and Sharma (1993)

**Organics**

Study conducted on wheat with organics on mountain acid lands (Sharma, 1987) demonstrated that an application of organics either 10 t FYM or 5 t poultry manure per hectare with 67 per cent of recommended NPK to wheat saved about 33 per cent of inorganics (NPK) giving wheat grain production, statistically similar to 100 per cent recommended inorganics (Table 18). Experiments conducted on onion with organics (Sharma and Raina, 1994) indicated that the use of 10 t FYM/ha improved the bulb productivity, P uptake and P-use efficiency to the tune of 14.5, 24.3 and 26.5 per cent respectively over no FYM, averaged over P application ranging from 30 to 120 kg $P_2O_5$/ha (Table 19).

**Table 18. Effect of organics and inorganics under integrated nutrient supply system in wheat in the mountain lands of Western Himalayas.**

| *Treatment | Grain Yield (q/ha) | | |
|---|---|---|---|
| | 1985-86 | 1986-87 | Mean |
| $N_{80}P_0K_{20}$ | 14.83 | 19.00 | 16.91 |
| $N_0P_{60}K_{20}$ | 16.57 | 29.17 | 22.87 |
| $N_{80}P_{60}K_{20}$ | 26.17 | 34.33 | 30.25 |
| $N_{120}P_{90}K_{30}$ | 35.00 | 41.83 | 38.41 |
| $F_{10}N_{10}P_0K_0$ | 15.17 | 21.33 | 18.25 |
| $F_{10}N_{80}P_0K_{20}$ | 28.30 | 31.83 | 30.06 |
| $F_{10}N_0P_{60}K_{20}$ | 17.50 | 38.00 | 27.75 |
| $F_{10}N_{80}P_{60}K_{20}$ | 35.07 | 41.67 | 38.37 |
| $PM_5N_0P_0K_0$ | 23.33 | 29.00 | 26.16 |
| $PM_5N_{80}P_0K_{20}$ | 32.50 | 44.83 | 38.66 |
| $PM_5N_0P_{60}K_0$ | 18.30 | 39.00 | 28.65 |
| $PM_5N_{80}P_{60}K_{20}$ | 36.33 | 45.67 | 41.00 |
| LSD (0.05) | 7.55 | 8.42 | 7.98 |

Source: Sharma (1987)

*N, P, K, F and PM indicate N, $P_2O_5$, $K_2O$, farm yard manure and poultry manure, respectively.

**Table 19. Effect of inorganics (P) and organics (FYM) on the productivity of onion, P uptake and P use efficiency in the soils of mid-west Himalayas.**

| Phosphorus ($P_2O_5$ kg/ha) | Bulb yield (kg/ha) | P-uptake (kg/ha) | P- Use Efficiency (%) |
|---|---|---|---|
| 0 | 2890 | 2.97 | - |
| 30 | 4494 | 5.92 | 45.24 |
| 60 | 5919 | 8.62 | 35.92 |
| 90 | 7117 | 11.45 | 29.15 |
| 120 | 8122 | 13.94 | 25.60 |
| LSD (0.05) | 504 | 0.68 | 4.95 |
| Effect of organic (FYM) (t/ha) | | | |
| 0 | 5334 | 7.65 | 23.64 |
| 10 | 6106 | 9.51 | 29.62 |
| LSD (0.05) | 798 | 1.07 | 3.13 |

Source: Sharma and Raina (1994)

Furthermore, some typical work having been accomplished on the use of organics with inorganics in pea and potato crops (Table 20 and 21) in the lands of high hills temperate dry zone of Himalayas; Parmar (1997) demonstrated a significant increase in tuber yield of potato and green peas with the application of FYM @ 10t per hectare with 75 and 50 per cent recommended inorganics (NPK) that could produce 238 and 187q / ha of potato tuber and green peas, respectively.

**Table 20. Integrated effect of organics and inorganics on green pod yield of peas in the soils of high hills dry temperate zone of Western Himalayas.**

| Treatment | Green Pod Yield (q/ha) | | |
|---|---|---|---|
| | 1996 | 1997 | Average |
| $T_1$= Control | 56 | 55 | 55.5 |
| $T_2$=$N_5P_{15}K_{7.5}$+ $F_0$ (25%) | 118 | 116 | 117.0 |
| $T_3$= $N_{10}P_{30}K_{15}$+ $F_0$ (50%) | 166 | 165 | 165.5 |
| $T_4$= $N_{20}P_{60}K_{30}$+ $F_0$ (100%) | 182 | 180 | 181.0 |
| $T_5$= $N_0P_0K_0$+ $F_1$ | 72 | 70 | 71.0 |
| $T_6$= $N_5P_{15}K_{7.5}$+ $F_1$ (25%) | 137 | 134 | 135.5 |
| $T_7$= $N_{10}P_{30}K_{15}$+ $F_1$ (50%) | 187 | 185 | 186.0 |
| $T_8$= $N_{20}P_{60}K_{30}$+ $F_0$ (100%) | 198 | 196 | 197.0 |
| LSD (0.05) | 15.0 | 12.4 | 13.7 |

Source: Parmar (1997)

**Table 21. Integrated effect of inorganics and organics on tuber yield of potato in the soils of high hills dry temperate zone of Western Himalayas (1996 and 1997).**

| Treatment | Tuber Yield (q/ha) | | |
|---|---|---|---|
| | 1996 | 1997 | Average |
| $T_1 = N_{50}P_{50}K_{25} + F_1$ (50%) | 136 | 134 | 135 |
| $T_2 = N_{75}P_{75}K_{37.5} + F_1$ (75%) | 216 | 215 | 215 |
| $T_3 = N_{100}P_{100}K_{50} + F_1$ (100%) | 234 | 232 | 233 |
| $T_4 = N_{50}P_{50}K_{25} + F_1$ (50%) | 169 | 170 | 169 |
| $T_5 = N_{75}P_{75}K_{37.5} + F_1$ (75%) | 238 | 240 | 239 |
| $T_6 = N_{100}P_{100}K_{50} + F_0$ (100%) | 250 | 248 | 249 |
| LSD (0.05) | 14.3 | 10.2 | 12.1 |

$F_1$=FYM applied @ 10 t/ha. $F_2$=FYM applied @ 20 t/ha

Source: Parmar (1997)

## Research and Development Gaps

Some useful work having been exhibited and demonstrated in this presentation, dominantly, pertains to the amelioration of mountain lands to win over the 'nutritional enigma' in respect of phosphorus, sulphur, lime, molybdenum for upgradation of the productivity of crops viz., wheat, turmeric, onion, chilli, cauliflower, lentil and potato, thereby, improving the livelihoods of small and marginal farmers living around such lands. However, there are other nutrients such as boron, iodine and magnesium which so far have remained neglected in respect of their role in improving the productivity of useful biomass systems on mountain lands. Consequently, special interventions are needed to study the individual and collective role of these nutrients in enhancing the productivity of cereals, pulses, vegetables and forage crops on these lands. Nevertheless, an emphasis needs to be laid more emphatically on the balanced use of primary, secondary and trace elements in the presence and absence of organics for the scientific management of these lands for realizing reasonably profitable productivity and food security. There is also a need for moderating the physical barriers standing in the way of good productivity on such lands namely low soil and water temperatures in winter and clod formation following rice harvest, on which, there are wide information gaps.

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## The role of bio-diversity in diversification for sustainable agriculture production and value addition

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The role of bio resources is well documented for better sustainability of Agriculture Production and Value Addition is now also relevant in context of the World Trade Organization (WTO) for all their confirmed positive effects as such in :

a. Poverty Alleviation
b. Economic upliftment.
c. Generation of Employment Avenues.
d. And for generation of more income comparing to the country's old traditional agriculture modes, methods, yields & incomes.

"It reminds me view point & thought of eminent German Scholar Max Muller what he observed about India "If we were to look over the whole world to find out the country most richly endowed with all wealth, power and beauty that nature can bestow in some parts a veritable paradise on earth, I should point to India".

Population in the modern world is likely to double in about 50 years. More than 12 billion people will have to be fed, and provided with job during these years however during these years the land and water resources shall go on shrinking, expanding ,biotic and abiotic stresses besides increasing genetic erosion and raising costs of fuel & energy.

Compounding economic and social problems will give rise to alterations in climate and sea levels and incidence of Ultraviolet radiation caused by some of the current industrial and agricultural technologies. The adoption of a revised UPOV convention for the protection of new varieties and plants, related bio-technological inventions, the statement of Green Industry Bio- technology platform and the acceptance of the concept of Farmers Rights in FAO meeting are significant in the debate on biotechnology and IPR. International Center for Genetic Engineering and Biotechnology (ICGEB) by UNIDO is a milestone in the history of biotechnology development in the third world.

International Conference on the agenda of science for environment and development into the 21st century (ASCEND 21) organised by ICSU and held at Vienna from 25-29 November, 1990, concluded that crisis likely within the lifetime of a half of the world's population arising from such changes as:-

- World population doubling to 12 billion in only 30 years.
- Migration and urbanisation assuming dramatic proportions, with notable consequences on coastal zones.
- Climate change, sea level rise and impacts on the biosphere.
- Irreversible losses of the total number of living species.
- Reduction and continuous deterioration of quality of the natural resource base, exhaustion, degradation, salinisation and loss of a major production of the global soils besides increasing water scarcity.

Bio-resources development in its natural form without tinkering would surely be a powerful instrument in alternate to the centuries old traditional modes & methods of agriculture.

As such without any further loss of time we should all devote ourselves in the development of institutional framework which will foster growth of global coalition resulting into removing the technological component of the wall dividing prosperity and poverty. Now the need of the present times is innovation and bio-diversification which are essential for alternatives to traditional agriculture as it resulted into rise in poverty, economic degradation and substantial reduction in avenues of employment amongst the rural masses in the world, within the frame work of sustainable agriculture in achieving the above objectives one such is mass propagation of bio-diversities as their materials being used in the great ancient science of life. Ayurveda is being rediscovered in Europe which is known for almost nil side effects, people in far East & Europe have realised that guaranteed health and longevity is the common and fervent desires of mankind of all ages.

Health and longevity are indeed life's most precious Jewels and for achieving this, medical scholars world wide working without rest to fulfill such an importunate solicitation. I have also a rare honour to be very closely associated with mass propagation and conservation of most economical and agro practices of such bio-diversities on scientific lines on the vacant, degraded lands, common village lands and also on degraded denuded forest land in India result into:

a. Socio-economic developments.

b. Enriching the flora & fauna.

c. Green cover to the denuded forest and common village lands.

d. Economic-upliftment of rural youth/masses.

e. Generation of more employment avenues.

f. Generation of substantial income as compared to the traditional crops which hardly make them to meet their basic needs and thus resulting into increasing poverty among them.

Almost 70 - 80% of the Indian population lives in rural areas where nothing changes and nothing remains the same. Indian subcontinent is larger than Europe and constitutes 4638 different communities who speak 1652 mother tongues, seven major religions, richness of heritage, customs, myths, legends, festivals, customs and especially folk medicines which have remained in use for the health care till date from the times immemorial and since western world grappling with stress and anxiety of daily life and now looking towards India, as a popular destination for supply of a variety of plant materials on sustainable basis for the production of a variety of safe & efficacious health cure products.

I would therefore, propose to all the concerned in government and otherwise engaged in achieving the above objectives under the banner of sustainable country's over all developments and the action plan there to, to:

1. Integrate bio-diversity into the formal education system.
2. Strengthen bio-diversity even outside PA'S
3. Traditional & Indigenous knowledge & equitable benefits.
4. Livelihoods and Bio-diversity system, 29/FA PESA Gram Panchayat Acts.
5. Holistic forest reforms.
6. Record livelihood uses of surveyed & un-surveyed forest land.
7. NTFP'S local consumption provoked extraction.
8. Involve pastorlists.
9. Pastoralist in JFM.
10. Monsoon grazing in PA'S.
11. Forests for interactions & coastal livelihood.
12. Stop industrial aqua-culture & promote sustainable practices.
13. Safeguard livelihood from cheap imports.
14. Community ownership and management of coastal resources.
15. Review dilutes in (CRZ) Costal Review zone.
16. Mass propagation of wide range of bio-diversities either endangered species are otherwise.
17. Formulate laws for getting the propagated bio-diversities extracted in systematic manner, under strict supervision and on scientific lines side by side mass propagation to continue in the vacant areas which will become available due to the extraction of bio-diversities by rotation.
18. Include such laws for severe punishment for disturbing the national natural inhabitants and resources whether it is endangered species and likely to be endangered due to ruthless extraction of bio-diversities.
19. Include training programs for the mass propagation and conservation of different bio-diversities as an important tool of the over all development of eco-systems.
20. Establish germplasm bank of different endangered and threatened bio-diversities.
21. Compile National Working Plan by compiling at district level and state level data base working plan.

22. Ecological mapping and area earmark for such bio-diversities developments.

23. National Bio resources development authority/board and state wise Bio resources development authority/board needs to be established.

24. Encourage the people from all walks of life particularly educated young from the rural and far flung areas for the training for conservation and mass propagation and developments of different bio-diversities, conservation of Environment and Ecosystem and this will help the district, state & the national administrators in achieving to a great extent.

# Sustainable development of rainfed agriculture

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**ABSTRACT**

In India out of total net cultivated area of 143 million hectares about 97 million hectares (68%) are rainfed, which produce 44 per cent of food requirements supporting 40 per cent of human population and 60 per cent of live stock. Jammu and Kashmir has a net sown area of 0.74 million hectares with cropping intensity and irrigated area of 144 and 28.4 per cent, respectively. With limited scope for enhancement of production in the horizontal direction, there is need to upgrade productivity vertically with the application of modern technology and inputs. Since the productivity in irrigated areas is now plateauing out, bulk of rising food demand in the country has to be met by enhancing productivity of rainfed areas. A growth rate in excess of 4 per cent is needed to be maintained in agriculture sector to achieve the production targets. Therefore, it is inevitable that second green revolution has to come from the rainfed areas and accordingly the application of production technology, inputs and investment are to be tailored to convert grey rainfed areas into green accompained by improvement in the quality of produce and reduction in cost of production so that our produce is globally competitive.

**Key words:** Rainfed agriculture, watershed, constraints.

## Introduction

The concept of sustainable agriculture which aims at enhancement in environmental, social and economic security should not be dealt only with reference to areas that have experienced the green reolution but is equally important for rainfed agriculture. The rainfed agriculture which represents 68 per cent of net cultivated area with a production of 44 per cent food grains, supporting 40 and 60 per cent human and live stock population, respectively [1], has innate problems of risk and instability which come in a way of sustenance of productivity goals. Identification of constraints to stabilize and mitigate weather related fluctuations under rainfed conditions through improved production technology, can help to achieve stability and required productivity in excess of 4 per cent growth rate [2]. Therefore, in this paper an attempt has been made to outline the constraints and suggest production technologies for sustainable rainfed agriculture.

**Constraints to sustainable rainfed agriculture**

Due to various constraints the average productivity in rainfed areas is only 0.7 to 0.8 t/ha as compared to 2.0 t/ha of food grain productivity under irrigated conditions [1]. The various constraints are:

**1. Climate:** The main climate elements, which limit the crop growth, are limited rainfall with erratic distribution, extreme temperatures and higher wind speed. Mean annual rainfall (Table 1) revealed that areas with lower values of mean annual rainfall had higher coefficient of variation and probability of drought occurrence. Under Jammu conditions although mean annual rainfall variation is only 20 per cent but the magnitude of variation for mean monthly rainfall is very higher indicating erratic distribution. The rainfall and evaporation relationship (Table 2) suggested the growing the season for *Kharif* crops from July to October under Jammu conditions.

**Table 1: Mean annual rainfall, coefficient of variation (CV) and probability of deficit rainfall at different places.**

| Station | Mean annual rainfall (mm) | CV for annual rainfall (%) | Probability (%) of occurence of deficit rainfall (<75% of normal) |
|---|---|---|---|
| Jodhpur (arid) | 369 | 55 | 51 |
| Anantpur (arid) | 568 | 30 | 38 |
| Hyderabad (Semi - arid) | 767 | 29 | 31 |
| Varanasi (Dry sub-humid) | 1026 | 25 | 25 |
| Ranchi (Wet sub-humid) | 1434 | 21 | 20 |
| Jammu* | 1189 | 20 | 5 |

Source: [1]; * Agrometeorology Obesarvatory, SKUAST - J.

**Table 2: Trends of monthly rainfall and pan evaporation under Jammu conditions**

| Month | rainfall (mm) | CV (%) | Epan (mm) | R-E (mm / month) |
|---|---|---|---|---|
| Jan | 35.0 | 88.3 | 15.4 | +19.6 |
| Feb | 50.7 | 66.9 | 28.3 | +22.4 |
| Mar | 57.8 | 98.1 | 116.1 | -58.3 |
| Apr | 34.9 | 106.9 | 202.8 | -167.9 |
| May | 12.5 | 134.6 | 186.0 | -173.5 |
| Jun | 49.0 | 64.5 | 180.0 | -131.0 |
| Jul | 318.3 | 48.9 | 135.6 | +182.7 |
| Aug | 497.8 | 53.5 | 113.1 | +384.7 |
| Sep | 135.8 | 76.5 | 102.6 | +33.2 |
| Oct | 78.1 | 147.1 | 75.8 | +2.3 |
| Nov | 25.2 | 131.3 | 44.6 | -19.4 |
| Dec | 5.2 | 135.4 | 25.0 | -19.4 |

Source: Agrometeorology Obesarvatory, SKUAST- J

**2. Soil:** The soils of rainfed areas are shallow, low in organic matter, low in fertility status, undulating topography, low biological activity with subsoil hard pan. It is estimated about 5333 million tonnes (16.35 t/ha) of soil is lost through erosion in India and of this nearly 10 perc ent is deposited in surface reservoirs resulting in the loss of 1 to 2 per cent of storage capacity [3]. Due to shallow nature of soils 42 per cent of total rainfall is lost through evaporation, 28 percent through run off, 7.5 per cent as deep percolation with only 22 per cent being retained in the soil profile [4].

**3. Technological:** For these areas there is non availability of resistant varieties, good data base is not available and adoption of improved production technology is very poor. The alternate cropping plans are not available for these areas. Adoption of technologies for post harvest management of the agriculture produce are also lacking in rainfed areas.

**4. Socio-economic:** Smaller and fragmented holding size as small and marginal farmers constitute 78 per cent of the total land holdings in India [5], higher population growth rate, illiteracy, inorganised marketing and distribution, poor infrastructure etc are the socio-economic constraints of rainfed areas.

## Production Technologies for Rainfed Agriculture

### A. Core strategies

These strategies involve the adjusting the functions of crop growth according to the prevailing physical factor through agronomic manipulation like:

**i. Off season tillage:** The off season tillage helps to improve water intake and control weeds. By this method sorghum (CSH-6) recorded a yield 12.4 q/ha as compared to 4.9 q/ha with plough and plant system [4].

**ii. Ploughing across the slope:** It is estimated that shallow furrows of 8-10 cm depth opened 20-25 cm apart can hold about 15 mm of water in the furrow depressions [6].

**iii. Adoption of appropriate *in situ* moisture conservation practices:** Land treatments like bunds, terraces, off season tillage, use of surface mulches and application of organic materials can improve *in situ* moisture conservation by way of increasing the opportunity time for rain water to infiltrate into the soil profile. Mulching and addition of organic materials help to conserve profile moisture by providing physical barriers on the soil surface so that rainwater get physical obstacle to runoff and checking evaporation. Application of FYM as mulch or branker (*Adhotoda vasca*) leaf mulch helped to enhance the wheat yield by 6.0 to 7.0 q/ha under dryland conditions of Jammu. In future, the use of crop residues for mulching will serve a better conduit for residual disposal.

**iv. Planting with earliest opportunity:** Earliest planting have the advantages like better moisture conservation, good seedling vigour, longer growing season, avoidance of pest and disease attack (e.g shoofly on sorghum, gallfly on rice and downy mildew on pearl millet), provides opportunity for second crop and avoids cooler season at flowering in case of *kharif* season crops.

**v. Selection of suitable crop matching with growing season:** Studies conducted on relationship between major rainfall pattern and growing crops gave following results:

| Rainfall Pattern | Crop | Region |
|---|---|---|
| Average dekad rainfall>80mm continuously for at least 8 dekads | Upland paddy | Varanasi, Bhubneshwar and Ranchi |
| Average dekad rainfall 60 to 80 mm continuously for 6-8 dekads | Maiza and Sorghum | Udaipur, Jammu Indore, Jhansi and Hyderabad |

| | | |
|---|---|---|
| Average dekad rainfall about 30 to 60 mm continuously for 6 dekads | Pearl millet Hissar | Jodhpur and |
| Average dekad rainfall of 30 mm or more for not more than 4 dekads | Minor millets | Anantapur, Bellary, Bijapur and Doda (Jammu) |

**vi. Proper Plant Population**: Rectangular planting has been found more benefical than square planting for crops based on conserved moisture under rainfed conditions. It is because closer spacing extracts more water, whereas wider spaced plants extract less moisture and also attenuates the evaporation due to surface drying [7]. The inter-cropping system with two or more crops with disparate root systems can help to over come risk and maximize water use-efficiency by extracting water from the entire root profile.

**vii. Timely weed control**: Weeds, if not properly controlled can take away as much as 30 per cent moisture and nutrients leading to substantial losses in yield [6]. Weed control not only improves crop yield but it also imparts stability in crop productivity (Table 3).

**Table 3: Effect of weed control on crop productivity and stability (mean of 9 years data)**

| Crop | Treatment | Yield (q/ha) Mean / Range | | SD (q/ha) | CV (%) |
|---|---|---|---|---|---|
| Rice | No weeding | 17.4 | 7.9 - 26.2 | 6.7 | 38.2 |
| | Weeding | 32.4 | 20.8 - 40.0 | 6.6 | 20.0 |
| Wheat | No weeding | 19.0 | 14.4 - 23.3 | 6.6 | 34.7 |
| | Weeding | 24.5 | 15.7 - 31.5 | 8.0 | 32.8 |

Source : [8]

**viii. Balanced fertilizer use**: The productivity of rainfed areas can be increased by adopting sound integrated nutrient management practices as these soils are not only thirsty but hungry also. The proper fertilizer management matching with the progress of monsoon and soil moisture availability enchance crop yields by 50 per cent with a minimum benefit to cost ratio 3:1 [1]. Conjunctive use of organic and inorganic is benefical with respect to improvement in crop productivity and soil fertility under rainfed conditions.

In India about 100 million tonnes of crop residues are available for recycling annually which are large reservoirs of plant nutrients containing 0.5, 0.6 and 1.5 million tonnes of N, $P_2O_5$ and $K_2O$ respectively [8]. The proper management of crop residues through treatment with efficient cellulolytic micro-organisms can help to improve physico-chemical properties of soils [9, 10. 11].

**ix. Need based plant protection**: Indiscriminate use of pesticides has resulted in the development of resistance, resurgence and residues in harvested produce and adverse effects on the non-target organisms in the eco-system. Therefore, there is need to develop need based plant protection measures matching with vagaries of climate under rainfed conditions so that the pesticides use is minimized and quality of the produce is improved in light of W.T.O.

**B. Water shed approach**

In India, of the utlizable surface water resources of 70M ha-m, only 36M ha-m is being utilized at present. Similarly out of an annual exploitable ground water potential of 42.3 M ha-m, only 13.5M ha-m are utilized [12]. The runoff also causes soil erosion to the tune of soil loss of 16.35 t/ha [3]. The water-shed approach with the following objectives related with word 'POWER' can be most suitable physical unit for integrated development of rainfed areas.

P - Production of food, fuel, fibre, fruit, fish, milk on sustainable basis
- Population control
- Pollution control
- Prevention of floods

O - Over exploitation of natural resources be avoided
- Operational practibility of all on-farm operations

W - Water storage and conservation
- Wild life and indigenous plants be conserved

E - Erosion control
- Eco-system stability
- Economic stability
- Employment generation

R - Recharge of ground water
- Reduction of drought hazards
- Reduction of siltation
- Recreation

**C. Crop diversification**

With a view to exploiting the agro-climate resources fully and also maximizing profits besides providing stability to production in rainfed areas there is need to develop diversified cropping systems by alternative land uses viz. agri-horticulture, agri-silviculture and silvi-pasture. There is also great scope for cultivation of medicinal, aromatic and dye yielding plants which have global demand in the coming years.

**D. Farm mechanization**

Use of farm implements which can help in timely sowing and fertilizer placement is needed to be popularized. CRIDA developed a low cost attachment to the farmers country plough which costs Rs 500.00, has been popularized for the plough and plant system [1]

**E. Live stock farming**

The rainfed areas not suited for crop production can be developed as pasture and grazing lands which can support live stock production and thereby can help to raise the economic status of the farmers.

**F. Development of contingent / alternative crop plans**

There is need to prepare contingent or alternative crop plans to meet the exigencies. These should be location specific as per amount and distribution of rainfall. Analysis of rainfall data of Jammu district w.e.f. 1975 to 2002 and its relationship with consumptive water use of gobi-sarson and wheat crop revealed that owing to water stress to wheat during March and April (period coinciding with flowering and grain nfilling stage), gobhi sarson can be grown as alternative to wheat crop (Table 4&5) [12].

**Table 4: Consumptive use of Gobis Arson Corp along with average effective rainfall w.e.f. 1975-1985, 1985-1995, 1995-2002 (mm).**

| **Crop Growing Period (160 days)** | | | | | | |
|---|---|---|---|---|---|---|
| Month | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. |
| Consumptive Use (mm) | 4.0 | 17.3 | 17.2 | 21.1 | 39.2 | 39.0 |
| **Effective Rainfall (mm)** | | | | | | |
| I | 10.4 | 17.4 | 14.0 | 42.0 | 37.0 | 46.0 |
| II | 29.9 | 11.6 | 33.0 | 33.0 | 46.0 | 45.0 |
| III | 28.7 | 12.0 | 0.0 | 33.0 | 30.0 | 30.0 |
| **Excess deficit** | | | | | | |
| I | 6.4 | 0.1 | 3.2 | 20.9 | -2.2 | 7.0 |
| II | 25.9 | -5.7 | 15.8 | 11.9 | 6.8 | 6.0 |
| III | 24.7 | -5.3 | -17.2 | 11.9 | -9.2 | -9.0 |

Source: [12]

**Table 5: Consumptive use of Wheat Crop along with average effective rainfall w.e.f. 1975-1985, 1985-1995, 1995-2002 (mm).**

| **Crop Growing Period (166 days)** | | | | | | |
|---|---|---|---|---|---|---|
| Month | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. |
| Consumptive Use (mm) | 9.6 | 12.3 | 16.4 | 35.8 | 64.1 | 40.5 |
| **Effective Rainfall (mm)** | | | | | | |
| I | 19.4 | 14.0 | 28.0 | 36.0 | 58.0 | 16.0 |
| II | 12.8 | 33.0 | 16.0 | 45.0 | 49.0 | 12.0 |
| III | 13.3 | 2.0 | 22.0 | 28.0 | 29.0 | 11.0 |
| **Excess deficit** | | | | | | |
| I | 9.8 | 1.7 | 11.6 | -1.8 | -6.1 | -24.5 |
| II | 3.2 | 20.7 | -0.4 | 9.2 | -15.1 | -28.5 |
| III | 3.7 | -10.3 | 5.6 | -7.8 | -35.1 | -29.5 |

Source: [12]

## Policy issues

To improve the productivity of the rainfed areas the policy issues like improvement in credit availability, extension of crop insursnce schemes to rainfed crops and suitable strategies for voluntary participation of farmers in the water sheds should be addressed by policy planners.

## Conclusions

The stability in rainfed agriculture preceded by sustainability can be achieved by negating weather-related fluctuations in yield, imposing appropriate water conservation measures and using land as per its capability accompanied by diversification of agriculture.

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# Tree nut improvement for sustainable production in hilly and rainfed areas of Kashmir

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## ABSTRACT

Mostly production of tree nut crops in J&K state is obtained from non-descript trees of seedling origin with low input or sub-optimal standards of husbandry. Proper choice of cultivars is prime determinant of transition from traditional to modern tree nut culture. Peculiarities of breeding system of nut crop and tremendous genetic diversity prevailing in the various agro-ecological zones characterised by rainfed condition with hilly and undulating terrain, offered a considerable scope to bring about tree nut improvement for sustainable production. Extensive surveys of germplasm of almond and walnut led to identification of promising types of high quality and better productivity. Stringent screening and selection among the genotypes earmarked in course of surveys resulted in the identification of elite types of high horticultural merit. Their further testing culminated into release of four almond varities (Makhdoom, Parbat, Waris and Shalimar) and two walnut varieties (Sulaiman and Hamdan). Identification of several other promising introductions and indigenous types of almond and walnuts represent another important landmark in genetic improvement of dry fruits. The implications of these attempts of dry fruit improvement have been highlighted.

## Introduction

The state of Jammu & Kashmir enjoys unique and varied climate in Indian sub-continent for successful production of almond and walnuts which are being cultivated over an area of 19,000 hectares and 60,000 hectares respectively. The state production is estimated as 7,000 metric tonnes of almonds and 73,000 metric tonnes of walnuts. The entire production of these nut crops is obtained from the acreage devoted to non-descript trees of seedling origin with low input or sub-optimal standards of husbandry. This offers considerable scope for improvement in productivity potential of these tree nut crops which indeed is tremendous. Proper choice of cultivars with improved genetic information is prime determinant of transition from traditional to modern tree nut culture involving a shift from a husbandry based on inferior agronomic practice to a husbandry based on scientific standards of optimal inputs. Fortunately, these nut crops are marked by several favourable features from the standpoint of bringing about improvement which have been exploited to the advantage of tree nut industry.

## Major challenges

Tree nut culture is beset with numerous problems which needs to be addressed in order to bring about improvement in status of nut crops in J&K State (Qureshi and Dalal,1985).Cultivation of these fruit crops is limited to hilly, rainfed and undulating terrain of temperate belt where farmers are mostly marginal practising cultivation either with practically no inputs as in walnuts or low inputs as in almonds. This calls for bringing about improvement in sustainable manner. Sustainablity needs to be viewed from the stand point of maintaining an increase in production while preserving underlying resource base so that meeting of todays needs do not become antagonistic to future opportunities. Tree nut improvement based on sustainability can be achieved keeping due regard of major challenges outlined as follows:

1. Low productivity of tree nut crops.
2. Lack of availability of quality plant material to meet the growing needs of area expansion, replanting and replacement.
3. Shrinking resource base (land, water etc.).
4. Growing competition as a result of trade liberalization and globalisation.
5. Stringent IPR regime for improved varieties.
6. Unforeseen threats of environmental stress and production instability.

In order to meet various challenges confronting tree nut industry, rejuvenating old orchards, supply of quality planting material of well defined varieties for area expansion and other interventions through integrated and mutually reinforcing package of technologies are critical for sustainable dry fruit production (Fig. 1).

TABLE-1: AREA, PRESENT PRODUCTION AND POTENTIAL OF TREE NUTS IN J&K STATE.

| Fruit | Present Area (lakh/t) | Production (lakh t) | | Productivity (t/ha) | |
|---|---|---|---|---|---|
| | | Present | Potential | Present | Potential |
| Walnut | 0.60 | 0.73 | 1.82 | 1.20 | 3 |
| Almond | 0.19 | 0.07 | 0.28 | 0.40 | 1.6 |

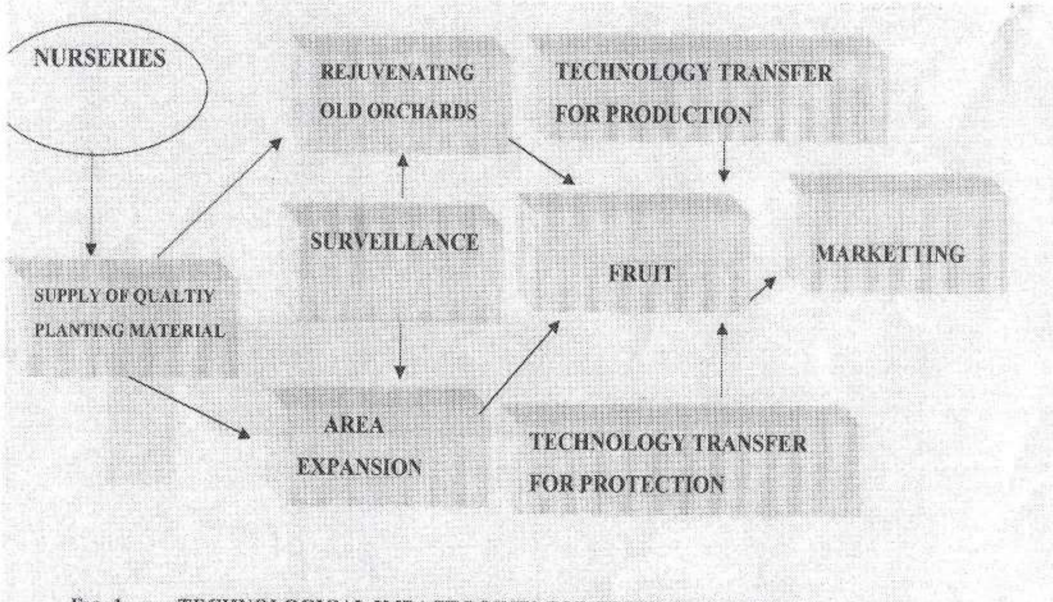


FIG. 1 : TECHNOLOGICAL IMPACT POINTS FOR FRUIT PRODUCTION.

Adoption of appropriate packages of technologies shall go a long way in realising productivity and production potential of almonds and walnuts (Table-1).

Production instability in a crop like almond renders it as chance crop discouraging enterpreneurial investment of resources for increased production. Extent of instability in almond production can be judged from the fact that state level production can be as low as few hundred tonnes to as high as 14,000 tonnes (Fig.2). Low production is attributed to abiotic stress due to unfavourable weather conditions during spring when almonds put forth their bloom.

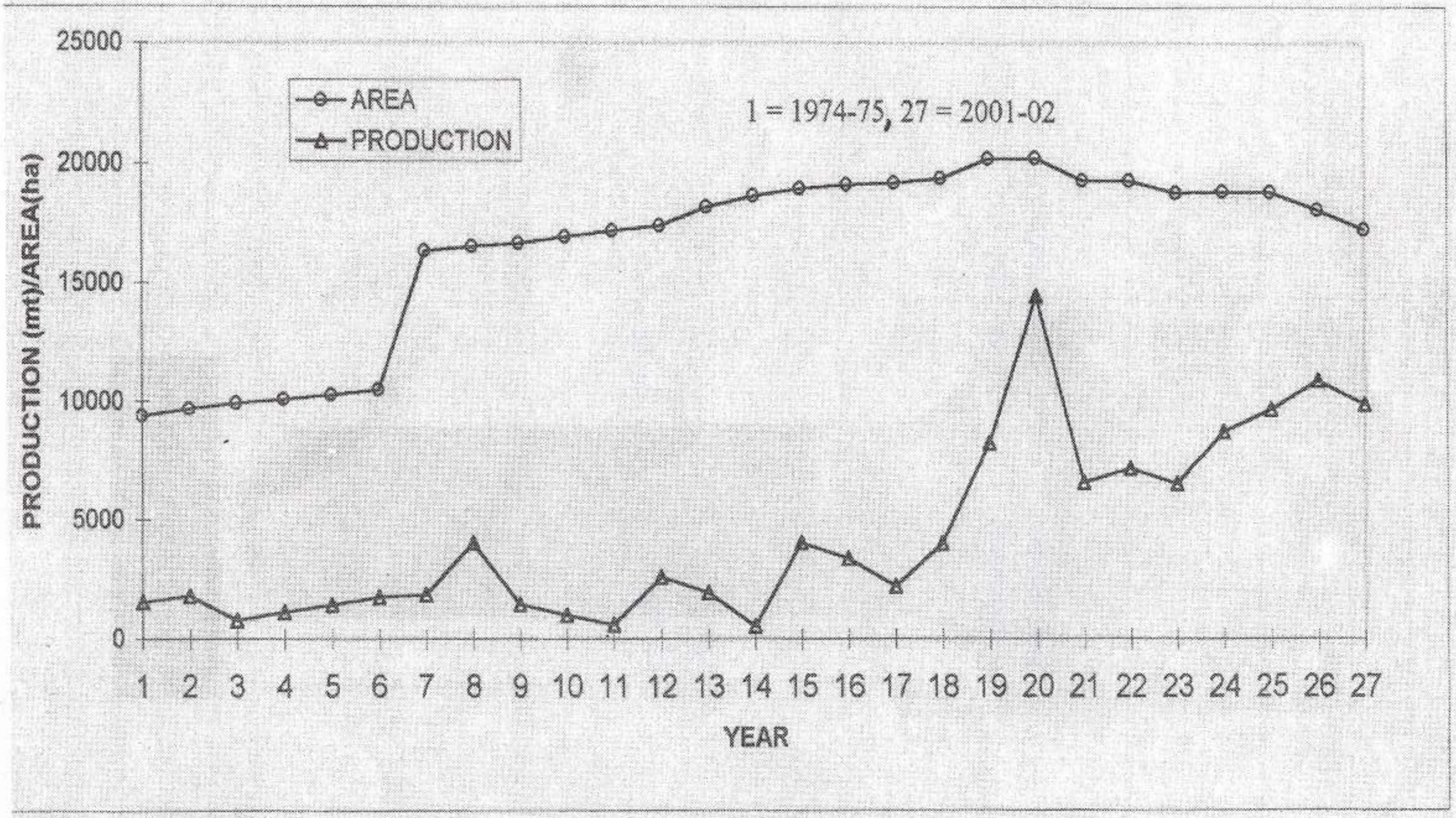


FIG. 2 : YEARWISE TRENDS OF PRODUCTION AND AREA UNDER ALMONDS IN J&K STATE.

## Breeding systems and objectives of improvement

Breeding system of almond and walnut is based on open pollination having propensity for out-crossing coupled with sexual and asexual mode of propagation. These characteristics of nut crops immediately suggest that they offer considerable scope of exploiting existing genetic variability. Numerous studies have shown that there is great genetic variability in tree fruit and nut species (Dalal *et al*. 2000 a,b; Hansche *et al*., 1972 and Kester and Assay, 1975). Where quantitative genetic analyses have been made, they generally reveal that most of this genetic variability is additive (Hansche *et al*., 1972), consequently breeding methodology involving least expensive selection scheme (mass selection) should be quite effective for improving tree fruit and nut cultivars. Further, heritability estimates of most of the quantitative traits of almond and walnut have been found appreciably high enough (Hansche *et al*., 1972) to suggest that these traits can be improved to meet commercial standards (Dalal *et al*., 2000b and Jain, 1968). These properties provide geneticist powerful engineering tools that is unavailable in most agronomic and vegetable species.

Crop improvement programme planned in S.K. University of Agricultural Sciences and Technology of Kashmir involves following major breeding objectives:-

* High consistent yield and high cropping efficiency.

* Greater Kernel tonnage per unit area.

* Better nut and Kernel quality conforming to commercial standards.

* Greater resilience to environmental variables particularly spring frosts.

* Wider adaptability.

* Improved resistance to various diseases.

## Landmarks in fruit improvement

Since the present population of almonds and walnuts are expected to be highly heterozygous and also in many cases heterogeneous; it is likely that several promising hybrids already exist (Hansche and Bares, 1980 and Dalal *et al*., 2000a) and allow for considerable scope for selection through extensive survey. This has led to some of the promising selections in almond e.g. HS-1, HS-2, HS-6,HS-9, HS-8, HS-10,AS-96, OAS-34, OAS-43, OAS-45, OAS-42, and in walnuts e.g. WS-22, WS-168, OWS-11OWS-17, WS-44, WS-169, Shalimar-2, Shalimar-10, Wossan-2, Wossan-8, (Anonymous, 1982, 1984; Dalal *et al.,* 1979a,b; 1982a, 1982b, 2000a,b) and other SKAU series of selections. With further screening and evaluation some of these selections hold the potential of becoming candidate cultivars for release and, in fact, four varieties have been released in almonds and two in walnuts. A controlled crossing programme was undertaken to isolate cross compatible groups of almond types (Dalal, *et al.*, 1988). Efforts have been made to assemble collections of almonds and walnuts by introducing some of the exotic material (Anonymous, 1982, 1984) so that wide range of variability is available for further improvement. Considering wide range of environment in the state of J&K, powerful genotype x environmental interactions are expected. Multilocational evaluation trials need to be taken up to exploit these interactions and screen the cultivars for wider adaptability.

**Performance of almond varieties vis-a-vis rootstocks**

For almond, growers can excerise wide choice of rootstocks. Studies revealed that scion varieties have an overriding influence on performance of composite almond trees budded on sweet almond or bitter almond (Dalal *et al.,* 1979b). Even peach rootstocks did not alter over all performance of almond varieties to any remarkable degree. Neither of rootstocks exerted any modifying influence on blooming behaviour. Even almond varieties budded on bitter almond rootstocks did not register any deleterious affect on organoleptic characteristics of kernel.

**Stability of fruit-set**

Vegetatively propagated almond selections were tested for blooming behaviour against late blooming almond introductions (Table-2). Based on variability in almond blooming, almond varieties were classified into early, mid and late blooming types and evaluated for stability in fruit set consecutively for seven years in terms of cofficient of variation. Early bloomers were relatively less stable in fruit-set as compared to mid or late bloomers (Table-3). In general, percentage fruit set, nut yield and cropping efficiency of late or mid bloomers was relatively higher as compared to early bloomers (Table-4). This difference in fruit set was attributed to the ability of late bloomers to escape abiotic stress due to inclement weather conditions.

**Compatiable Pollinizers**

Almond cultivars are mostly self-incompatible and this is of gametophytic type. Self-incompatibility is an out breeding mechanism which maintains high degree of heterozygosity in almond. Once the cultivating of dry fruits register a shift from non-descript trees of seedling origin to one of well-defined vegetatively propagated varieties, problem of cross-incompatibility between various varieties, especially in almonds, is bound to pose a serious problem. Various almond varities with effective overlap of blooming period and

**TABLE-2:** **Grouping of Almonds Cultivers on the Basis of Approximate Bloom Period.**

| Early | Mid | Late |
|---|---|---|
| HS-7(-11)* | HS-39(-3)* | Jordanolo(+11)* |
| HS-26(-5)* | HS-4(-2) | Merced (+10) |
| HS-29(-5) | **Parbat(-2)** | Nikitskij (+10) |
| K1-77(-5) | HS-27(-2) | |
| | Perhick's Wonder (-1) | |
| | **Mukdhoom (o)** | |
| | Afganistan Seedlin (0) | |
| | Chellestan (+1) | |
| | **Shalimar (+2)** | |
| | I.X.L. (+2) | |
| | HS-5(+2) | |
| | HS-6 (+3) | |
| | **Waris (+3)** | |
| | Non-pariel (+3) | |
| | Pranyaj(+4) | |

* Figures in parenthesis indicate approx. number of days before and after beginning of Mukhdoom bloom.

* Average blooming dates of Mukhdoom ; initial bloom -- 13/3, 50% bloom-20/3, full bloom (80-100%) - 22/3.

*. Early blooming - flowering at least five days earlier than Mukhdoom

* Late blooming flowering at least five days later than Mukhdoom

TABLE - 3: Coeffecient of variation (Per cent) of production parameters of various almond blooming groups

| Production Parameters | Bloom groups | | |
|---|---|---|---|
| | Early | Mid | Late |
| Final fruit set | 60.83 | 21.46 | 18.01 |
| Nut yield / tree | 54.36 | 18.32 | 16.23 |

TABLE - 4:Production parameters of various almond blooming groups averaged over genotypes

| Production Parameters | Bloom groups | | |
|---|---|---|---|
| | Early | Mid | Late |
| Final fruit set(%) | 14.00 | 16.87 | 22.00 |
| Nut yield / tree (Kg) | 2.05 | 2.31 | 2.98 |
| Cropping effeciency | 6.25 | 8.81 | 11.66 |

* Figures in parenthesis indicate number of genotypes

cross compatibility, were tested for fruit set (Dalal *et al,*. 1988). These and other studies led to the identification of cross-compatible and cross-incompatible combination of almonds amongst the released varieties (Table-5). Growing of cross-compatible group of varities in a consolidated block shall improve fruit-set appreciably resulting in enhanced production.

TABLE -5 Cross - Compatible and Cross Incompatible Cultivar Combinations of Almonds

| MAIN TREES | POLLINIZERS | | | |
|---|---|---|---|---|
| | Mukhdoom | Parbat | Waris | Shalimar |
| Mukhdoom | X | X | ✓ | ✓ |
| Parbat | ✓ | X | X | X |
| Waris | ✓ | X | X | ✓ |
| Shalimar | ✓ | X | ✓ | X |

X = Cross - incompatible combination ; ✓ Cross - compatible combination

**Almond and walnut cultivars released**

Culture by seed propagation has been widespread since the beginning of almond cultivation in Kashmir valley. The stand of seedling almonds represent highly variable and hetrogeneous group as a result of high degree of hetrozygosity. Members of the group are typified on the basis of the shell hardness, viz, hard shelled (duda),medium shelled (darmiani) and paper shelled (Kagzi). These almond types are regarded as cultivars despite the fact they lack uniformity in may respects. The lack of uniformity in almond produce is a dominant feature of this industry in Jammu and Kashmir state. Almost similar situation prevails in Iraq, Turkey, Greece, Afghanistan, and other areas where the practice of almond culture by seed propagation still exists in varying degrees(Table-6)

Table - 6: Productivity of Newly Released Almond Varieties

| Cultivars | Yield at 15 years age (kg/tree) | 5 years average yield (kg/tree) | Difference average yield over average of other selections serving as checks | Yield difference over state average | Yield (kg/ha) |
|---|---|---|---|---|---|
| Mukhdoom | 3.6 | 2.5 | 0.5 | -1.5 | 675.0 |
| Shalimar | 1.4 | 1.9 | 0.1 | -0.9 | 508.0 |
| Waris | 2.8 | 2.4 | 0.4 | +1.41 | 650.0 |
| Parbat | 2.7 | 1.7 | 0.3 | +0.7 | 464.0 |

Vegetatively propagated cultivars originating from chance seedlings, or from breeding programmes and adopted as standard cultivars is a characteristic of intensive industrial production areas of California, France, Australia, Spain and Italy. Attempts on similar lines for cultivar development programme in J&K state were initiated in late sixties and early seventies (Dalal *et al.*, 1979ab, 1982 abc and Anonymous, 2002) which culminated into the release of four almond cultivars, viz. Mukhdoom, Parbat, Waris and Shalimar during 1995 and two walnut cultvars,viz Hamdan and Sulaiman during 2002. Salient features of these varieties are given below.

**Mukhdoom:-** Tree is large in size and spreading; fruits are borne mostly on one year but some are borne on spurs. Nut size: medium; shell colour: moderately yellowish with sparsely pored surface. Shell : semi soft; seal: good ; kernel: medium sized and plump. Shelling percentage around 38-42%. It is a mid season variety and is ready in first week of August. It takes 143 days from full bloom to maturity. Sweet or bitter almonds have been observed to be good rootstocks for *Mukhdoom, Shalimar* and *Waris* cultivars may be used as pollinizers. Mukhdoom is moderately susceptible to leaf spot and die back, slightly susceptiable to gummosis, but show field resistance to leaf blight and leaf blotch. The variety is moderately and slightly susceptible to leaf curling aphid and Grey weevil respectively but has exhibited field resistance to mealy bug.

Table 7: Nut And Kerenal Characteristics of Released And Promising Almond Cultivars

| Cultivars | Nut Weight | Kernel Weight | Shelling Percentage | Double Kernel(%) | Shell Hardness | *Cropping Intensity |
|---|---|---|---|---|---|---|
| Mukhdoom | 2.9 | 1.2 | 42 | 14.1 | Semi hard Shell | 6.5 |
| Shalimar | 2.6 | 1.2 | 47 | 17.3 | Soft Shell | 6.5 |
| Waris | 2.4 | 1.5 | 60 | 20.2 | Paper Shell | 7.5 |
| Parbat | 1.6 | 0.8 | 47 | 9.9 | Soft Shell | 6.0 |
| Merced | 1.8 | 1.0 | 64 | 4.2 | Paper shell | 6.5 |
| Pranyaj | 3.1 | 1.7 | 5.5 | 14.1 | Paper shell | 6.0 |
| Primorskij | 3.7 | 1.8 | 49 | 21.0 | Soft shell | 6.5 |

i-9 Scale : 6 = good, 7 = very good

**Parbat:-** Tree is meduim in size and upright to spreading. Fruits are borne on one year shoots some on spurs. Nut size : small; shell colour whitish yellow; matures at 140 days after full bloom. Kernels are smooth having good colour and very good appearance and taste; shelling percentage on an average is about 47 %. It is mid season variety and ready for harvest from 1-2nd week of August, performs well under rainfed conditions. Cultivar *Mukhdoom* should be used as pollinizer. The variety is moderately susceptible to die back, slightly susceptible to leaf spot and leaf blotch, but shows field resistance to leaf blight and gummosis. This variety is moderately susceptible to leaf curling and slightly to Grey weevil and mealy bug.

**Waris:-** Tree is upright and medium in size, it is a regular bearer, bears mostly on one year old wood, nut size is medium and has soft-paper shell. Colour moderately yellow with densely pored surface; shell seal: good; meduim sized; mid to late variety and is ready for harvest in third to last week of August i.e. at 147 days after full bloom. *Mukhdoom* and *Shalimar* almond cultivars should be used as pollinizers. The cultivar is moderately susceptible to die back and gummosis, slightly susceptible to leaf spot, but has shown field resistance to leaf blight and leaf blotch. Moderately susceptible to leaf curling aphid, slightly susceptible to Grey weevil, but exhibits field resistance to mealy bug.

**Shalimar:-** Tree is medium in size with spreading behaivour. Nut appearance is appealing and has high shelling percentage (47 %); shell colour : light yellow with moderately pored surface; mid to late maturing group. Ready for harvest at 146 days after full bloom i.e. 3rd to last week of August. Kernels are smooth having good colour and very good appearance and taste. Almond cultivars *Mukhdoom* and *Waris* should be used as pollinizers for this variety. This variety is moderately susceptible to leaf spot and leaf blotch, but exhibits field resistance to leaf blight and die back. This variety is moderately and slightly susceptible to leaf curling aphid and Grey weevil, and has shown field resistance to mealy bug.

**Hamdan:-** The average nut weight is 14g or more, precocious starts bearing after 3rd year of grafting, having a shelling percentage 54% with a good yield potential. The tree is somewhat dwarf and spreading. The leaflets are elliptic, serrate,light green in colour. The variety is protandrous, but stigma recpetivity is overlapped for 2-3 days by another dehiscence of *Sulaiman* variety of walnut. Female flower abundance is intermediate. The nut is ovate in shape with more than 80 % light coloured kernels. The variety belongs to mid maturity group. Nut is ready for harvest 138 days after full bloom.

**Sulaiman:-** Average nut weight in this selection is 21g with a shelling percentage of 52 %. This selection has highest bearing potential and is productive upto 60 % on lateral. It can increase yield from present. 1.40 t/ha to 3.0 t/ha without much efforts. The tree is semi-dwarf and spreading. The leaflets are broad elliptic, serrate and dark green in colour. The selection is protandrous and *Hamdam* can be used as pollinizer for this selection. Female flower abundance is high. The nut is round in shape with more than 50% light coloured kernels. This variety belongs to mid maturity group. Nut is ready for harvest 142 days after full bloom.

**Vegetable Propogation of trees nuts**

Despite the fact that remarkable achievements have been made in bringing about genetic upgradation of almond and walnut, any effort in imparting varietal status to these tree nut crops was dogged by implementational loopholes for want of reliable and easy to handle technique of vegtative propagation. In almonds shield budding is the technique of choice. With the adoption of this technique defined varieties of almond together with desired pollinizers compatible with the main variety can be multipled on large scale. In walnuts, however, various efforts made earlier did not result in the development of comparably easy to handle technique of vegetative propagation. Hot cable callusing (HCC) techinque was introduced for successful grafting of walnuts. This technique consists in covering of grafts union with a pair of insulated cables covered with adhesive tapes. An electrical wire runs throughout the length of cable which is heated with thermostatically controlled power supply for maintaining temperature regime of 25 $\pm$ 2°C. A success of 50-60 per cent graft take was obtained through HCC technique. The limitation of this technique is relatively high cost of imported equipment and lack of assured and round the clock electricity. In order to circumvent this problem a technique of utilising zero energy high humidity polyhouse for successful propagation of walnuts has been developed. Heavy duty polythene resting on a wooden or iron frame covered on all sides pro vides the requisite structure which provides in the polyhouse elevated thermal conditions with average temperature difference ranging from 5°C to 8°C above ambient field temperature during February to March. Elevated temperature in the polyhouse is conducive for callusing at graft union which is critical for successful grafting. Temperature in the polyhouse should not be allowed to exceed 27 $\pm$1°C. Grafting undertaken from last week of February to 1st week of March and maintaining high humidity (above 90 %) either with the help of humidifer or manual sprinkling of water twice a day in the polyhouse gives success of around 80 per cent. This technique is relatively easier to handle than hot cable callusing (HCC) technique.

**Conclusion and future outlook**

Consolidation,evaluation and enhancement are the essential features of dynamic germplasm systems which has the potential of saving the traditional varieties from extinction and making available wide range of variability within almond and walnut species, much of which has not yet been fully utilized or systematically exploited. Germplasm pools could be considered as the feed-stock for varietal development either by way of selection from open pollinated seedlings or planned breeding programs. Concerted and continuous efforts are needed to rectify the deficiencies in almond and walnut germplasm and intergrate some exotic germplasm into adapted germplasm so that hidden variability is released to meet the challenges of cultivar improvement. Breeding material is available in the germplasm to bring about remarkable improvement in production potential and cropping efficiency. There are considerable prospects of producing latter blooming and hardier type of almond. The sizeable variability in nut and kernel characteristics holds the promise of bringing about profound improvement in qualitative aspects of almond and walnut culture.

Productivity and nut and kernel characteristics of some introduced varieties and newly released almond varieties (Table-6and7) and walnut varieties (Table-8and 9) indicates that adoption of these varieties shall bring about radical changes in the scenario of dry fruit

**Table -8 : Average Nut Yield of Released and Promising Wal Nut Cultivars**

| Selections/ | Yield kg/tree at the age of 5 years | Yield (kg/tree) | Yield gain over Chenovo (kg) | | Yield gain over Opexcaulchery (kg) | | Yield gain over state average (kg) | |
|---|---|---|---|---|---|---|---|---|
| | | | $Ha^{-1}$ | % | $Ha^{-1}$ | % | $Ha^{-1}$ | % |
| Hamdan | 15 | 2250 | 150 | 7.1 | 750 | 50 | 850 | 60.7 |
| Sulaiman | 30 | 4500 | 2400 | 114.3 | 300 | 200 | 3100 | 221.4 |
| SKAU-W-008 | 20 | 3000 | 900 | 42.8 | 1500 | 100 | 1600 | 114.2 |
| Chenovo | 14 | 2100 | -- | – | – | – | – | – |
| Opexcaulcherry | 10 | 1500 | -- | – | – | – | – | – |

Average of 5 years; * Sate average : 1400 kg/ha

**Table -9 : Nut and Kerenal Characteistics of Released and Promising Walnut Cultivars**

| Selections/ introductions | Nut Characteristics | | | Kernel characteristics* | | | |
|---|---|---|---|---|---|---|---|
| | Nut length (cm) | Nut breadth (cm) | Nut weight (g) | Kernel colour | Kernel weight | Kernel fill (g) | Selling % |
| **Hamdan** | **4.4** | **3.46** | **14.7** | **1** | **8.05** | **7** | **56.76** |
| **Sulaiman** | **3.9** | **4.04** | **21.5** | **2** | **11.26** | **5** | **52.34** |
| **SKAU-W-008** | **3.38** | **3.42** | **11.4** | **2** | **6** | **5** | **52.63** |
| **Chenovo** | **3.38** | **2.81** | **5.27** | **1** | **4** | **5** | **50.82** |
| **Opexacaulchery** | **3.14** | **3.2** | **07.8** | **2** | **3.8** | **5** | **48.71** |

* Kernel colout : 1 = extra light, 2= light, 3= light amber and 4-amber likeness ; Kernel fill : 3= poor, 5=moderate, 7 = wellfill

production in the state as it shall lead to:

- imparting varietal status to tree-nut industry currently based on heterogenous and non-descript trees of seedling origin;

- stable production of globally competitive uniform produce amenable to sorting, grading and processing with relative ease; and

- better use of shrinking land and other resources by way of higher productivity, cropping efficiency, profitablility and sustainability associated with elite varieties

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## Producation technology of temperature fruit crops in rainfed hilly areas of north-western himalayas

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### Introduction

Most of the temperate fruits like apple, pear, cherry, almond, apricot, pomegranate, nut crops etc, have come to us from Southern Europe and Western and Central Asiatic Region. The fruits which are popularly known as "hill fruits" or "cold region fruits" are grown at locations of about 3000 ft above mean sea level in hilly areas of Himachal Pradesh, Nagaland, Meghalaya etc. Mount Abu hills of Rajasthan and Nilgiri hills of Tamilnadu also provide some favourable climate for these fruits. However, as of today, temperate fruit industries is more developed in North-Western Himalayan region of India.

Although the area under temperate fruits has increased manifold during the past few years, yet we stand no where in comparision with other horticultural advanced countries in the productivity and quality of these fruits. Under World Trade Organisation (W.T.O) which came into force w.e.f. Jan. 1995, the products of a country need to be globally competitive and sometimes a country has to sell the produce below the production cost. Among various temperate fruits, apple has been recognized as successful farming system for subsistence moutain agriculture which also has great potential for export. Nut fruit crops which have their place in the economy of Jammu and Kashmir also have immense scope for export and can very well be exploited in North-western hill region.

### Area and Production of Fruits

At national level about 6.5 percent of total cropped area is under fruit cultivation and the corresponding for Himachal Pradesh is 21.0 percent. Himachal Pradesh produces 3,99,951 MT of temperate fruit crops from 1,38,469 ha of area (Anonymous, 2001). These areas show a wide gap between the potential and the actual yields. The overall scnario of hilly states in respect of fruit productivity, is given in Table 1.

**Table 1: Area and production of fruits in N-W Himalayan states (2000-2001)**

| State | Area (000 Ha) | Percent share | Production (000 MT) | Percent share | Productivity (MT/Ha) |
|---|---|---|---|---|---|
| Jammu & Kashmir | 140.9 | 3.62 | 837.3 | 1.19 | 5.9 |
| Himachal Pradesh | 213.0 | 4.78 | 438.3 | 1.04 | 2.1 |
| Uttaranchal | 198.8 | 4.58 | 541.0 | 1.35 | 2.8 |

NHB Data base (2002)

From these figures, it is clear that though Himachal Pradesh has more area, but the fruit production is less than 50 per cent that of Jammu and Kashmir. There has also been rapid increase in area in other north-eastern states under cultivation but their production is also showing a declining trend.

There is wide gap between actual production and the potential. For example the productivity of apple in India is 5.1 tonnes/ha, whereas apple productivity in western countries is 40-60 tonnes/ha. No fruit industry can sustain at this exceedingly low level of productivity. We have to upgrade this productivity to atleast 15.0 MT/ha for new plantations from existing 6-8 tonne/ha.

**Constraints in Production**

In almost entire North-western hill areas except valley areas of J&K, the orchards are largely established under rainfed conditions resulting in drought as well as excess of moisture at times. The 'On' farm water resources are very scanty as the natural water resources are only in form of perennial streams located either at far away distance or at an elevation lower than the orchards. The other main problems caused in low productivity is due to the change in climate scenario regulating into insufficient.

**Strategies for Fruit Production in Rainfed Areas**

Rainfed horticulture in other sense means dry land horticulture . In India dry lands are availbale in plenty. This is a common feature in hilly areas, where except rainfall no other major source of irrigation is available. The farmers in rainfed areas are economically poor with low ability to withstand risk and their holdings are small and marginal which are also scattered. They cannot make large capital investments on soil and water conservation. Chilling, occurrence of spring fruits and hails, lack in pollination and prevalence of insects, pest and diseases. All problems are to be managed in such a way that our production cost could be minimized and productivity and quality increased to compete the global market.

The strategy for development of rainfed areas include either development of assured irrigation facilities or growing suitable tree species in pits which have some drought resistance. Development of irrigation infrastructure is costly, therefore, hardy fruit species on their drought tolerant rootstocks with appropriate nutrient mixtures is cheaper option for development of arid horticulture and increase production in these areas.

**1. Selection of fruits Crops**

**Temperate, Sub- temperate and temperate arid zone**

i) Apple
ii) Walnut
iii) Almond
iv) Pear
v) Stone pine ( Chilgoza)
vi) Pistachio nut
vii) Hazel nut

**2. Orchard Planting Technology ( Layout)**

The orchards in hilly area should be planted in small terraces or contour system having inward slope. This helps in reducing the surface run-off of natural rains and also helps in conserving water for use by the plants.

**3. Plants Raising Technology**

*In-situ* raising technique of fruits plants is a very successful technology for rainfed areas. This has been largely adopted for walnut, pecan, and many other fruit plants which are otherwise difficult to be established after transplanting . Plants of pecan and walnut are also raised in polybags and transplanted in the rainy season.

**4. Collection of Run-off water**

The rainwater in hilly areas can be stored in ponds of appropriate sizes. This has been the practice in Switzerland, where large earthen ponds have been constructed at the top of hills. The water of these reservoirs is also used in summer for domestic use in scarcity period and moreover water percolates downward thereby resulting in more moisture in lower slopes.

*In suit* run-off concentration technique is most suited for fruits crops becasue of being deep rooted. They are able to utlize the moisture stored in lower soil layer and can produce optimum crop even in low rainfall. Secondly once they are established, they can continue to produce for many years. Planting of fruit plants in Kandi areas of foothills of Himachal Pardesh like apricot, peach, pear with V- ditch method gave maximum survival ( 64.0%) followed by Crescent bund method of planting. (Fig-I) This has been reported due to more moisture availability in these methods ( Anonymous, 1997).

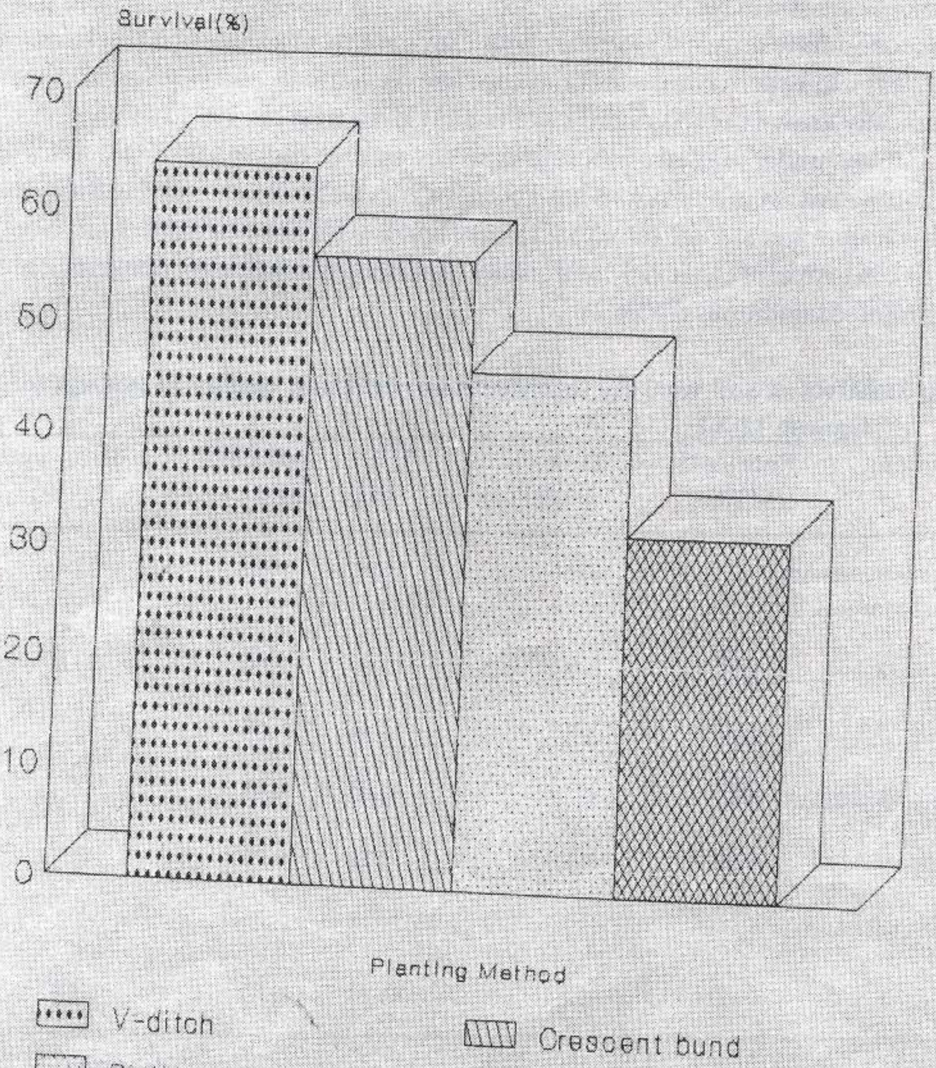


Fig.1 Survival(%) of fruit crops under different planting methods

In *in situ* technique , the plants are grown in such a way that each plant / tree has its own micro catchment area, the size of which is determined by the slope. This technique has been successful in ber plantations where ber tree with canopy of $36m^2$ (6x6m planting), can be sucessfully grown if produced with $75m^2$ canopy in a slope of 5.0 percent ( Singh et al., 2001). In Israel a number of fruit crops like fig, almond, peach, grape etc. have been successfully grown in such micro catchments ( Evenari *et al.,* 1971).

Even under rainfed conditions moisture storage through different soil working techniques in existing plantations have been found beneficial in increasing fruit yield and quality. Rain water storage through Crescent bunds with open catchment pits have been effective in increasing fruit yield and quality in existing plantations of pomegranate plants under rainfed conditions (Table 2).

**Table 2: Effect of soil working techniques on yield and quality of pomegranate cv. Ganesh (2002)**

| Treatment | Fruit yield (MT/ha) | Fruit weight (g) | TSS ($^0$B) | Reducing sugars (%) | Total sugars (%) |
|---|---|---|---|---|---|
| Crescent bund with open catchment | 7.27 | 226.6 | 13.16 | 9.78 | 12.11 |
| Grass mulch | 5.66 | 220.1 | 13.08 | 9.66 | 11.87 |
| V-ditch | 5.07 | 204.3 | 13.00 | 9.57 | 11.74 |
| Trench system | 4.25 | 193.7 | 12.66 | 9.48 | 11.40 |
| Control (traditional basin) | 3.38 | 187.8 | 14.34 | 9.29 | 11.12 |
| $CD_{0.05}$ | 0.29 | 1.81 | 0.04 | 0.02 | 0.02 |

Sharma, N. (2003)

## 5. Moisture Conservation

Conservation of soil moisture through mulching and determination of irrigation timings are two useful steps that can help in effective water budgeting of fruit plantation in dry lands. Mulching the tree basins with waste organic material such as grasses, paddy straw, black polythene or refractive polythene mulches, pine needles or oak leaves as per local availability can be used. These materials prevent loss by evaporation, checks weed growth, maintain optimum temperature and also improves the organic matter content of soil.

In general mulching increases vigour and growth of fruit trees (Haynes, 1980). Peach tree vigour and survival of plants in Pennsylvania orchards planted on slopes in eroded lands were fully dependent on mulching materials. Black polythene mulch was found very effective for moisture conservation in northern hemisphere as well as in our northern slopes in apple. Mulches also increased yield on shallow soils in Australia (Baxtor, 1970). The rest of orchard should have sod/legumes.

The mulches have also been found benefical for plant growth and production of apple under high hill conditions where the drought is experienced during fruit growth in summer. In an experiment conducted recently under Network Project on enhancing productivity of apple in India, the fruit set and fruit yield was significantly increased by various treatments (Table 3).

**Table 3: Effect of mulches and herbicides on growth and fruit production in apple plants on MM106 rootstock (2003)**

| Treatment | Annual shoot growth (cm) | Fruit Set (% on spur basis) | Yield (kg/plant) |
|---|---|---|---|
| Dry grass | 32.60 | 8.41 | 35.62 |
| Black polthene | 34.50 | 9.98 | 38.84 |
| Pine needles | 32.59 | 7.14 | 35.12 |
| Oak leaves | 31.68 | 7.32 | 30.20 |
| Herbicides | 29.40 | 5.41 | 27.41 |
| Clean cultivation | 28.32 | 6.69 | 27.28 |
| $CD_{(0.05)}$ | 1.50 | 0.85 | 1.40 |

## 6. Organic Farming

Due to continuous use of mineral fertilizers, our soils have been badly depleted and their structure has been distributed. Such soils have low water holding capacities. Organic farming can be a major option because of the increasing realization that accumlation of chemical residues in the soil, water and plants as a consequence of continued and inefficient use of chemical fertilizers and pesticides can result in severe human and animal health problems. Health consciousness about food and non food products and their consumption is dramatically changing in favour of organic products. Though this may result in lower yields but net returns are more. Efforts need to be concentrated on recycling of agricultural green waste. In this case organic material is returned to the soil to retain the humus content of soil. This also checks soil erosion and depletion of water resources. This will increase opportunity for our land fills.

**7. Crop regulation through chemicals and PGR's**

Due to indiscriminate expansion of apple cultivation to marginal and unfavourable areas which are prone to environmental vagaries, temperate fruit crops flowering and fruit setting is adversely affected. Manipulation of flowering and fruit set in these marginal areas through use of nutrients and plant bio-regulators have proved effective. Pre-bloom spray of urea (0.5%) combined with boric acid (0.1%) and $ZnSO_4$ (0.25%) resulted in higher fruit set (24.69%) and productivity (21.98 MT/Ha) under Kullu conditions (Table 4).

**Table 4: Effect of pre- bloom nutrient applications on fruit set and yield in apple cv. Starking Delicious (2000)**

| Treatment | Fruit set (in 100 spurs) | Yield (Kg/ha) | Productivity (MT/ha) | Yield efficiency (Kg/cm²) |
|---|---|---|---|---|
| Urea (0.5%) | 21.06(4.59) | 41.10 | 20.30 | 0.11 |
| Boric acid (0.1%) | 18.55(4.31) | 39.87 | 19.70 | 0.11 |
| $ZnSO_4$ (0.25%) | 16.88(4.11) | 31.50 | 15.56 | 0.09 |
| Urea (0.5%)+ Boric acid (0.1%) | 19.44(4.410) | 41.62 | 20.56 | 0.15 |
| Urea (0.5%)+ $ZnSO_4$ (0.25%) | 19.423(4.41) | 39.75 | 19.64 | 0.13 |
| Boric acid (0.1%) +$ZnSO_4$ (0.25%) | 20.49(4.53) | 40.57 | 20.04 | 0.15 |
| Urea (0.5%) + Boric acid (0.1%) +$ZnSO_4$ (0.25%) | 24.69(4.97) | 44.50 | 21.98 | 0.13 |
| Control | 15.11(3.89) | 29.87 | 14.76 | 0.10 |
| C.D(0.05) | 0.50 | 0.87 | 0.43 | 0.03 |

The bloom of apple cv. Solard, sweet cherry and peach trees was effectively protected from frost with spray of frost guard (1.5 to 2.0%) or Vit. E (0.25%) combined with 5.0%

glycerin (Holubowicz, 1993). Similary application of tricontanol in plum increases fruit set.

**8. Management for Biotic and Abiotic Stresses**

Under rainfed conditions, there is increased problems of insect, pests and disesses. For example stone fruits have problem of scale, pome fruit have excessive Sanjose scale, European red spider mite etc. Drought conditions aggravate the physiological problems like deficiency of boron, calcium affecting fruit set and fruit quality.

All these problems need to be given due care. Under heavy drought conditions, anti-traspirants like kaolin (10%) and PMA have been found effective in checking the moisture loss from leaf surface resulting in increased production (Godara, 2001).

**9. Watershed Management**

The system of watershed has been used by mankind since antiquity. This system is now being taken up at National level Schemes in which participation of village people is involved for construction of watershed structures like check dams, construction of ponds etc. This will check the soil erosion and the water stored is utilized for agricultural development. This type of activity has been augmented in Shiwalik areas of Himachal Pradesh and other hilly states.

**10. Use of drought tolerant rootstocks**

The new clonal rootstocks have been developed for various temperate fruit crops keeping in view the specific problems. The various rootstocks which are drought tolerant can well be used under rainfed conditions. Some of these are listed below:

| Fruit crop | Rootstocks |
|---|---|
| Apple | MM-111, KC-1, Merton-793 |
| Pear | Oregon-260, Kainth |
| Peach | GF-677 |
| Plum | Myrobalan-27, Wild apricot |
| Almond | GF-677 |
| Walnut | Paraodox |

**11. High density plantations**

The traditional orchards of temperate fruits have been planted at very low density at a spacing of 20-25 ft. These orchards come into commerical bearing after 10-15 years in comparison to dwarf orchards which come into commerical fruiting after 5-6 years.

The superiority of high density planting in apple cv. Vance Delicious employing MM-106 rootsock have been demonstrated in Dr. Y.S. Parmar University of Horitculture and Forestry at RHRS, Mashobra, where yield upto 75 tonnes/ ha has been recorded in comparison of 4-5 tonnes/ ha average yield of the State . Similar high productivity has been recorded in a 10 years old high density plantings in Progeny-cum-demonstration orchard of State Department of Horitulture (Table5)

**Table -5 Fruit set and yield of spur apple cultivars on MM -106**

| Cultivar | Fruit Set (in 100 Spurs) | | Productivity ( tonnes/ha) | |
|---|---|---|---|---|
| | 1998 | 1999 | 1998 | 1999 |
| Well spur | 62.33 | 38.50 | 48.51 | 27.40 |
| Starkrimson | 58.33 | 30.17 | 43.14 | 31.84 |
| Silver spur | 65.00 | 35.83 | 45.92 | 30.36 |
| Red Chief | 68.00 | 47.00 | 51.66 | 35.55 |
| Oregon spur | 74.67 | 48.83 | 54.43 | 38.51 |
| **Mean** | **65.67** | **40.07** | **48.73** | **32.73** |

Perusal of data clearly shows the higher productivity under high density planting system of apple on semi dwarfing rootsocks.

Similarly in July Elberta peach, under rainfed conditions a yield upto 36.70 tonnes/ha was obtained with a planting density of 666 trees/ha in meadow system of planting(Anonumous, 2002). From the perusal of data presented in Table 6, it is revealed that highest yield (26.50 kg tree) was obtained under open vase system followed by hedge row (23.70 kg /tree). Whereas the higher producitvity was obtained under meadow system followed by tatura trellis system.

**Table 6 : Effect of different training systems on yield and productivity of July Elberta peach.**

| Planting Systems | Yield (kg/tree) | Productivity (tonnes/ha) |
|---|---|---|
| Open Vase | 26.50 | 10.60 |
| Hedgerow | 23.70 | 18.96 |
| Tatura Trellis | 17.12 | 34.24 |
| Meadow | 14.68 | 36.70 |
| **C.D.** $_{05}$ | 5.33 | 7.15 |

Similarly high -density plantings of cherry, plum, apricot are being raised in various overseas institutions giving higher productivity. The high density planting can be raised in flat lands and valley areas where irrigation facilities are avialable. In other hilly areas also the spur type/ genetically dwarf cultivars can be planted on seedling rootstocks at almost double the density than the conventional plantings.

**12. Drip Irrigation/ Fertigation**

For efficient utilization of harvested water, drip irrigation is the most suitable option for fruit crops. This is a relativity new method of irrigation initially developed by Israel. It is known as daily flow irrigation in Australia and Trickle irrigation in USA & UK. It entails frequent application of water and nutrients directly to the root zone to replinish water and other nutrients which have been utlized by plants.

The fruit crops are recommended to be irrigated bi-weekly during March, April, July-November and on alternate days in May and June . The total annual requirement through drip irrigation system in midhill Zone of Himachal Pradesh for peach and apricot have been found to be 2800 and 2250 litres per plant respectively ( Thakur, 2002) . In drip irrigation experiment in apple with plant density of 830 per ha, Levin *et al.* (1980) recorded as high yields as 100 tonnes/ hectare.

**Summary**

The cultivation of temperate fruits in India is confined mainly to the North- Western Himalayan Region comprising the states of Jammu & Kashmir , Himachal Pradesh and Uttranchal. Although the area under temperate fruits has increased manifold during the past few years, yet we stand nowhere in comparison with other horticluturally advanced countries in the productivity and quality of these fruits . For Instance, the productivity of apple in India is merely 5.1 tonnes/ha as against the world average of 11.06 tonnes and more than 30 tonnes in advanced countries. The cultivation of these fruits under rainfed conditions and the lack of appropriate production technologies are the major factor responsible for low yields and poor quality of these fruits.

In the Post -WTO regime, the whole world has become one market and it is only through quality improvement, cost competitiveness and efficient marketing systems that we can compete in the global market. The benefits of the liberalized trade under WTO regime can only accrue if our horticultural enterprise gears up not only to compete with imports but also takes advantage of opportunities of export. The establishment of Agriculture Export Zones for fruits like apple and walnut in J&K and H.P. will hold not only in promoting the production but also in the export of value added products of these fruits.

The production technologies such as use or regular and high yielding varieties, use of drought tolerant rootstocks, high density planting, organic farming, integrated pest and disease management, *in situ* moisture conservation through micro catchment areas, organic and inorganic mulches, micro-irrigation , fertigation, use flat lands and valley areas of plant growth regulators, etc. can successfully be employed for the enhancement of productivity and quality of different temperate fruit crops for domestic as well as the export market. Experiments conducted by Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni- Solan on high density planting in apple cv. Vance Delicious on MM-106 rootstock have shown that apple productivity can be increased to a potential level of 75 tonnes against the national average of 5.1 tonnes/ha, while in peach the productivity can be increased from 3-4 tonnes to 27 tonnes/ha. Similarly the productivity in pomegranate can be increased from 3.88 tonnes to 7.27 tonnes/ ha by using rainwater conservation technique of crescent bund with open catchment.

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# National Scenario in Development and Acceptability of Transgenic Crops

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Transgenics or GMOs are the organisms with a gene or genetic construct of interest that has been introduced by molecular or recombinant DNA techniques. These exclude organisms produced by conventional breeding as well as organisms produced by intraorganism rearrangement of genetic materials. Transgenics carries transgene (s) which confer either a new trait to the organism which was hitherto not present (for instance, insect resistance) or enhance an already existing trait (for instance, nutritional quality).

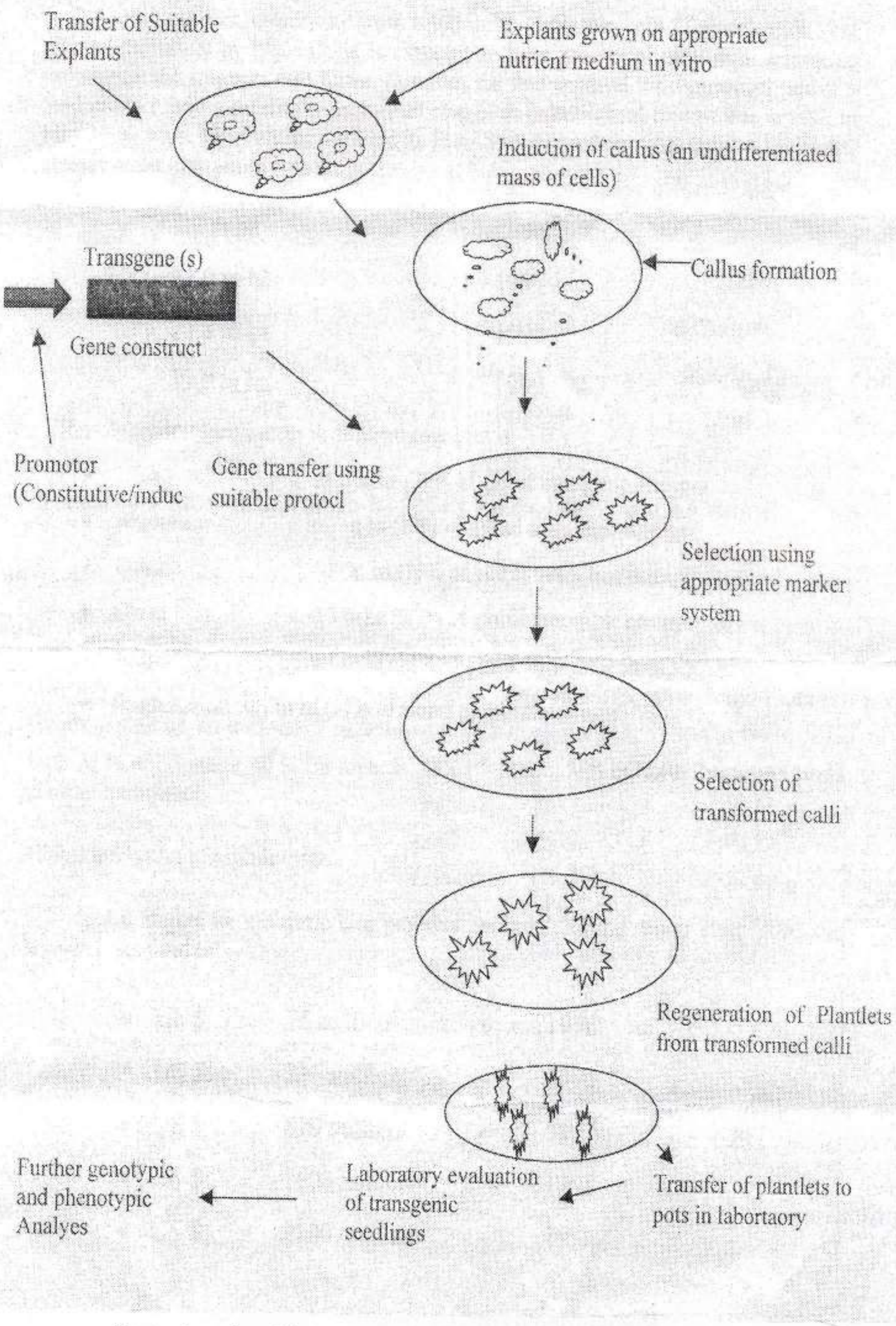
**Creating Transgenic Plants**

The major steps in a laboratory procedure for obtaining transgenic plants are :

- Creation of suitable gene construct.
- Transfer of this gene construct into plant cells, tissues *in vitro* through a process called 'transformation'.
- Selection of transformed cell lines or seedlings using a suitable marker system and regeneration of fertile plants from the transformed cells.
- Analyses of transformed plants for several aspects including stable integration, expression and genetic behaviour of transgene(s) .

**Area under cultivation in transgenic crop varieties**

China was first country to grow commercial transgenic crop (Tobacco with viral disease resistance) in 1986. China is expected to have substantial area under transgenic maize, rice and cotton in near future.However, the first approval for commercial sale of a food product from a genetically engineered crop in an industrialized country was in USA in May 1994, when M/S Calgens marketed its Flavr Savr delayed ripening tomato.




Steps involved in creating of transgenic plants in a laboratory

The global acreage under transgenic is as under :

| | | |
|---|---|---|
| 1.7 m ha | - | 1996 |
| 11.0 m ha | - | 1997 |
| 27.8 m ha | - | 1998 |
| 39.9 m ha | - | 1999 |

The global transgenic areas in different countries is

- USA : 28.0 m ha (72% of global transgenic acreage)
- Argentina : 6.7 m ha (17% of global transgenic acreage)
- Canada : 4.0 m ha (10% of global transgenic acreage)
- China : 0.3 m ha (0.7% of global transgenic acreage)
- Australia : 0.1 m ha (17% of global transgenic acreage)
- South Africa : 0.1 m ha (17% of global transgenic acreage)

25% of US maize, 40% US soybean, 45% US cotton, 35% of North American Canola is under transgenics.

**Global market for transgenic crops**

Global market for transgenic crop products has been growing rapidly since 1995 and has been estimated as :

- US $ 75 million - 1995
- US $ 235 million - 1996
- US $ 670 million - 1997
- US $ 1600 million - 1998
- US $ 2100 million - 1999

Within a short span of 5 years revenue from transgenic crops increased by 30 fold.

It is further estimated that global market for transgenic crops would reach approximately US $ 8 billion in 2010.

**Applications**

The salient applications of genetic engineering worldwide are:

- Engineering for biotic stress resistance

  Resistance to insect-pests

  Resistance to diseases

- Engineering for abiotic stress tolerence

- Engineering for herbicide tolerence
- Engineering for pollination control
- Reducing post harvest losses
- Development of value added food products.
    - Improving oil quality
    - Improving protein quantity and quality
    - Improving starch content
    - Improving vitamin content

**Research on transgenic crops in India**

Several institutes under ICAR and CSIR and SAU's are actively involved in research on transgenics covering tobacco, rice, mustard, cotton, potato, brinjal, tomato, cabbage, cauliflower etc. Transgenic varieties of brinjal, mustard, cotton and tomnato are also under field trials. At present the characters predominantly targeted by institutions carrying out genetic engineering experiments in both public and private sectors in insect-pest resistance using Bt gene. Several crops including rice, cotton, tobacco, potato, tomato, brinjal, cauliflower, cabbage and pigeonpea are being targeted for this purpose.

Transgenic lines in advanced stage of development or field testing are as under:

| Institute | Crop | Transgene Inserted | Aim |
|---|---|---|---|
| CTRI, Rajmaundari | Tobacco | Bt toxin gene | Resistance to Tobacco caterpillar |
| CPRI, Shimla | Potato | Bt toxin gene | Resistance to Potato Tuber Moth |
| IARI, New Delhi | Brinjal | Bt toxin gene | Resistance to Shoot and Fruit Borer |
| IARI, New Delhi | Rice | Bt toxin gene | Resistance to yellow stem borer |
| IARI, New Delhi | Tomato | Bt toxin gene | Resistance to Fruit Borer |
| IARI, New Delhi | Cabbage | Bt toxin gene | Resistance to Diamond back Moth |
| IARI, New Delhi | Tomato | ACC synthase gene | Delayed fruit ripening |
| IARI, New Delhi | *Brassica juncea* | Annexin gene from Arbidopsis | Tolerance to moisture stress |
| IARI, New Delhi | Potato | Osmotin | Tolerance to moisture stress |
| DRR Hydrabad | Rice | Bt toxin gene | Resistance to yellow stem borer |
| DRR Hydrabad | Rice | Chitinase gene | Resistance to sheath blight disease |
| Bose Institute, Calcutta | Rice | Bt toxin gene | Resistance to yellow stem borer |

| | | | |
|---|---|---|---|
| Bose Institute, Calcutta | Rice | Bt toxin gene | Resistance to yellow stem borer |
| Delhi University | Mustard/ rapeseed | Barnase and Barstar | Pollination control for hybrid development |
| JNU New Delhi | Potato | Amal gene from amaranthus | To improve nutritional quality |
| CICR, Nagpur | Cotton | Bt toxin gene | Resistance to lepidopteron insect pest |
| M/s Proagro | Mustard/ Rapeseed | Barnase and Barstar | Pollination control for hybrid development |
| M/s Proagro | Tomato | Bt toxin gene | Resistance to lepidopteran insect pests |
| M/s Proagro | Brinjal | Bt toxin gene | Resistance to lepidopteran insect pests |
| M/s Proagro | Cauliflower | Barnase and Barstar | Pollination control for hybrid development |
| M/s Proagro | Cauliflower | Barnase and Barstar | Resistance to lepidopteran insect pests |
| M/s Proagro | Cabbage | Bt toxin gene | Resistance to lepidopteran insect pests |
| M/s Mahyco | Cotton | Bt toxin gene | Resistance to lepidopteran insect pests |

**Three-tier mechanism for evaluation of transgenic in India**

India has laid out detailed biosafety guidelines for experimentation and release of genetically modified organisms. These guidelines have been notified in official gazette of the GOI by Ministry of Environment and Forestry through notification No. 621 dated December 5, 1989.

The recombinant DNA safety guidelines are based on 3 tier system involving.

- Institutional Biosafety Committee (IBSC)
- Review Committee on Genetic Manipulation (RCGM)
- Genetic Engineering Approval Committee (GEAC)

The IBSC is estabalished at every institution engaged in research on genetically engineered organisms. The RCGM and GEAC closely monitor the field experiments involving transgenics before their commercialization is contemplated as well as granting permission for commercial use of the products containing GMO's.

## Testing of transgenic plants

Transgenic lines obtained through **transformation and regeneration**

↓

**Laboratory Analysis to confirm**
- Stable integration of transgene (s)
- Number of copies of the transgene
- Expression of Transgene (s)

↓

Monitoring and Analysis of transgenics in a **containment (Glasshouse) facility** for
- Stability of transgene expression
- Agronomically desirable expression of transgenic trait (s)
- Genetic behaviour of transgene (s)
- Biosafety evaluation and risk assessment

↓

**Small-Plot (<500 $m^2$) Field experiments** to evaluate Agronomic performance and to further analyze biosafety.

↓

**Large-Scale field Testing** at Multiple Sites

↓

**Commercialization** of transgenic variety after risk assessment and evaluation of net benefit offered by the transgenic.

↓

**Monitoring** of transgenic variety during commercialization.

**Bio-safety Concerns**

Biosafety refers to policies and procedures adopted to ensure environmental safety during the course of development and commercialization of transgenic organisms. Production of wide spread use of transgenic crops is suggested to have following major risks.

- Escape of engineered genes by 'gene flow or gene dispersal'.
- Non-target effects or ecological effects.
- Invasivenessorweedinessoftransgenic.
- Creation of 'super-weeds' and super-viruses'.
- Toxicity and allergenity tohuman beings andanimals.
- Expression of undesirable phenotypic traits.
- Erosion of biological diversity.

**Biosafety Guidelines**

Information needs to be generated on the following specific question for evolving a dynamic regulatory framework for risk assessment and release of transgenic plants.

* When, where and how should the trials be carried out ?
* Can the transgenic plant escape, survive and multiply in the wild or as a weed in the region of the proposed trial ?
* What are the experiences already been gained with the open field trials ?
* Is there any possibility to avoid possible risks with transgenics and to manage risks during commercialization ?

**Assessment of Biosafety**

Assessment of biosafety of transgenic crops should obtain as much information as possible in a time frame to answer the question :

- What purpose the transgenic is meant for ?
- What transgene (s) is carrying ?
- What are the products expected to be synthesized by the transgenic ?
- What could be the possible impact of the transgenic or its products on the flora and fauna.

## CONSTRAINTS

### Somaclonal variation

Transgenic plants obtained by *in vitro* culture may show obtained somaclonal variation which denotes variation among *in vitro* requested plants which are expected to be uniform and genetically identical. This necessitates production of a large number of independently transformed plants for proper selection of those individuals with desirable phenotypic expression or agronomic performance.

### Gene Silencing

In some cases it has been observed that the transgenic has either become silent or has been lost in subsequent cycles of breeding due to process called gene silencing. The mechanism underlying gene silencing and the possible strategies to overcome this problem are being investigated by research groups in various countries.

### Difficulties in precise insertions

Many times precise insertion (s) is/are not obtained during transformation with the result the transgenics are instable in their performance.

### Huge investment

Plant transformation process requires considerable financial investment, good laboratory, infra-structure and support facilities and above all, manpower with good technical skills in molecular biology and tissue culture.

### Risk assessment

- Field releases or tests of transgenic plants so far did not cause any problems.
- Critics of transgenic technology have refuted the above statement.

### Food Safety Issues

- Krattiger and Raman (1996), reported that Bt insecticidal protein is not harmful to mammals, birds or fish or to most beneficial insects.
- Scientists had transformed soybean with the 2S gene from Brazilian nuts. Allergic reaction was triggered when some people consumed the transgenic

soybean.

- Consumption of a number of a transgenic plants will result in a cumulative effect of resistance to antibiotics which can be problematic.
- Rats showed high mortality rates when fed with potato transformed with the 'lectin' gene constuct.
- According to some reports, a small proportion of human population (1-2%) suffer from food allergy.

**Social, economic, ethical and moral issues**

Crops need to be rotated, isolation distances maintained and farmers told how to grow them. How will farmers with small land holdings be able to grow transgenic crops ? Also there should be a certain area of refuge crop all around the field of transgenic crops.

**IPR Issues**

- Under the TRIPS Agreement, microorganisms need to be patented. Animals are not required to be patented. Plants are patented under the ***suigeneris*** system.

**Food Labelling Issues**

- In India, since transgenic crop products are yet to hit the market, food labeling has so far not been an issue.

**The Challenges**

- 'Gene Silencing' and instability of transgenics.
- Implementing resistance managment strategies.
- Conserving agro-biodiversity.
- Intellectual property rights, plants breeders' rights and farmers' privilege.
- Transgenics and socio-economic implications.
- Some ethical challenges.
- Public awareness and acceptance.

# Need to Bring transgenic technology to Farms

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## ABSTRACT

The gain in food production achieved through the application of "GREEN REVOLUTION" technologies have reached to a plateau. Contrary, our country continues to show alarming increase in popuation growth coupled with dwindling natural resources. In order to ensure food security for the ever-increasing population, address the problems of malnutrition especially in children and pregnant women and utlize natural resources more efficiently and judiciously, the application of modern technology-Biotechnology or transgenic technology in all the area of the agriculture offers a great hope.

Whereas , the application of bio-technology has become essential in agriculture to enhance the productivity, nutrient content of fruits and cereals, increase their shelf life, improve the environment, the introduction of GM crops has become highly controversial and the main objections of the use of GM crops is the possible harm to human health and the environment. But till date no real dangers to GM Foods have been documented.

Since our country has predominant population of marginal farmers, the course of biotech inverstigation is required to be re-directed towards subsistent and sustainable farming and benefits of biotech research whether in private or public sector are required to be given to small marginal farmers on priority . The cost factor of GM seeds need to be given due attention to make it afforable to the small and marginal farmers.

In our country "Green Revolution" has been a great technological success of the 20th century. By the introduction of new high yielding varieties of maize, wheat , rice, bred on scientific lines, the production increased manifold. However , the gains in the food production achieved through the application of green revolution technologies have reached to a plateau, the ecosystem also got disturbed through the excessive use of chemical fertilizers and pesticides which has been found to affect adversely the human and animals. It has recently come in ICAR News letter that the taking raw vegetables is harmful to human and animal health in view of these having good percentage of traces of pesticides. Not only this, milk has also been seen to be highly contaminated. Recently at a place, amongst 9% of milk samples collected, 5% were found to have traces of endosulfan above the dangerous level. Even the distilled water available in the market has been reported last month as unsafe for humans because of having high traces of pesticides. The country on the other hand continues to shaw alarming rise in population growth coupled with dwindling and degraded natural resources like land, water and biological diversity. Thus, the developing country like India is confronted with many tough challenges like ensuring food security, addressing the problems of the nourishment especially in children and pregnant women as well as the efficient use and conservation of natural resources. To address these burning issues, dramatic advances are required and it is not conceivable that agriculture can deliver the expected output without the application of biotechnology.

Several terms have been coined to describe the biotechnology such as genetic engineering, genetic transformation, transgenic or GM technology. This GM technology involves transferring DNA (the genetic material) from a plant or a bacterium or even an animal into a different plant species. With the appropriate technology genes determining particular characteristics could be identified and put in to plant cell that require modification. The meaningful application of biotechnology in agriculture is shown in Fig.I.

**Biotechnology and Agriculture**

- **Plant cell tissue and organ culture**
- **Transgenic Technology**
  - Increasing photosynthetic efficiency
  - Increasing nitrogen fixing ability.
  - Increasing shelf life.
  - Hybrid crops.
  - Crops for food processing etc.
  - Disease resistance.
  - Insect resistance.
  - Herbicide resistance.
- Somatic hybrids.
- Transgenic Animals (Molecular Farming)

**Fig. 1**

**The major uses of biotechnology are:-**

i. Faster identification and characterization of varieties

ii. Faster development of different varieties

iii. Quicker multiplication of the desired material.

iv. Environmental safety by replacing pesticides and chemical fertilizers with biopesticides and biofertilizers and conservation of natural resources.

It is envisaged that next "Agricultural Revolution" "The Evergreen Revolution" will be based on ***"Invitro"*** technology.

Biotechnology is taking firm roots in many advanced countries with many genetically modified crops finding place in vast agricultural farms. Several Indian Institutes and organizations (public as well as private sector) have claimed to have developed transgenic plants some of which are either under field evaluation or are ready for field use and field evaluation/polyhouse evaluation. Some of the major Indian developments in transgenic plants are :-

I. Development of Bt cotton (Fig.2) by Maharashtra Hybrid Seed Company showing resistance to boll worm. (***Heliothis Spp.***)

II. Insertion of Bt toxin gene in rice by BOSE Institute, Calcutta.

III. Bt toxin gene in potato by CPRI, Shimla for generating plants resistant to lepidopteran pests.

IV. Insertion of Snow drop (***Galanthus nivalis***- a plant of family Amaryllidacea) lectin gene into chilly, belpepper and tomato for resistance against lepidopteran, coleopteran and homopteran pests, respectively by Rallis India ltd. Banglore.

V. Similarly a salt tolerant gene from ***Avicennia marina* (family = verbenaceae)** has been identified, cloned and transferred into plants by MS Swaminathan Foundation Chennia. Such plants have been found to have tolerance to higher concentration of salts.

VI. The gut D gene from ***E.coli*** has been used to generate salt tolerant transgenic maize plant.

VII. Similarly an enzyme producing gene from the bacteria which lives in human colon has been cloned and used to help plants survive better in areas with excessive sun shine. This technology would go in long way to grow agriculture and horticulture in deserts and water deficit areas.

VIII. GM technology has also been found to improve the appearance and color of fruits, vegetables,flowers etc; increase their shelf life and enhance the nutrient content of fruits and cereals.Even the caffeine free coffee plants have been developed to avoid the ill effects of caffeine on human health.

IX. The GM golden rice developed exhibits increased content of B carotene as a precursor to vitamin-A. This golden rice has been found useful in check ing the vitamin A deficiency in children causing them partially or totally blind.

X. Advanced countries have also produced "edible vaccines" where in transgenic plants have been used for manufacturing of pharmaceutical compounds- genes that code for therapeutic proteins have been inserted into a variety of commonly grown crops like tomato and soybean. Some of the therapeutic proteins produced by transgenic plants include antibodies, antigenes, hormones, enzymes etc;

XI. Antibacterial/Anti-microbial proteins produced by plants/animals also have wide applications in therapeutics besides being used as food and feed preservatives. Antibacterial proteins have also been isolated from ***B.mori*** larvae in response to gram negative strain of bacteria ***(E.coil)*** in Biotechnology Laboratory SKUAST(K). 70KDa and 10KDa antibacterial proteins have been successfully isolated (Fig. 3,4). After analyzing these proteins by aminoacid sequencing and cloning these could be used for various applications.

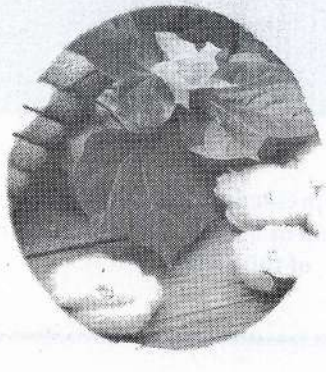

**Fig. 2 Bt Cotton**

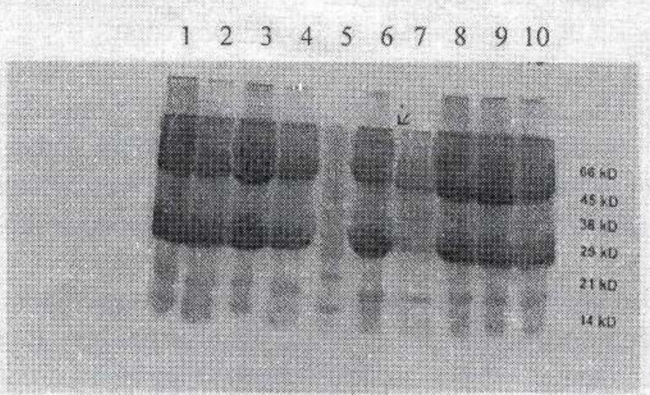


**Fig 3 Lane 6 shows the presence of 70 KDa peptide which is secreted in response to the Gram-negative strain of bacteria.**

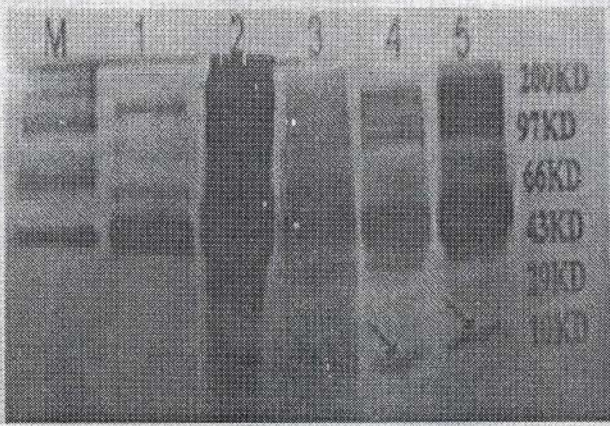


**Fig 4 Lane 2,3,4 and 5 shows the presence of 10 KDa peptide which is secreted in response to the Gram-negative strain of bacteria. Lane 1 (control) shows the absence of this band.**

Important factors that necessitate the intervention of biotechnology to improve productivity, profitability, stability of the farming system are:-

**a) Population growth and food security**

In spite of efforts by the Govt; the population growth is increasing considerably both at global level and individual country level (Table-1).

**Table-1: Population Growth (in millions) and food grain production (million tonnes) in India**

| Year | 1950 | 2000 | 2025 | 2050 |
|---|---|---|---|---|
| Population | 362 | 994 | 1309* | 1513* |
| Food Grain Production | 51 | 200 | 325** | 500** |

* UN/World Bank Estimates (2001)
** Productivity yield.

Therefore, the pattern and pace of agriculture growth to feed the burgeoning population should not be in just global terms but more in terms of individual countries taking into account the trends in population growth in the context of the available land, water and other resources.

There may be considerable food production and availability of buffer stock in our country but hunger and malnutition widely exists. Certainly, the great challenge ahead is to produce sustainably, produce quality foods and distribute it equitably and adequately to the people. The biotechnology offers great promise in meeting the food demands for the burgeoning population. The advocates of GM Technology claim that GM foods will end up hunger and benefit the consumer.

**b) Environmental Safety**

The Prime Minister in his address at a biotechnology conference on 2001 has said that "increase in food production has come at a cost to the environment, with both qualitative and quantitative degradation of land, water and other resources.

The denudation of forests, soil erosion, water logging, and salinisation of soil, excessive use of pesticides and chemical fertilizers, excessive urbanization etc; have damaged the environment and also led to the ecological imbalance. Therefore, unless the ecological dimensions are added to agricultural producation plans and rehabilitation, it will be difficult to sustain exploitative agriculture over a long period of time.

Biotechnology has opened new avenues for working with the nature by the production of biopesticides, biofertilizers, by producing the plants that extract nitrogen from air and by producing plants that are adopted to harsher environmental conditions, require less moisture content, producing plants having tolerance to biotic stresses as new and quicker avenues for managing and conserving the gene wealth.

### c) Economic Sustainability

In densely populated countries like India, the average size of farm holdings is becoming smaller day by day. The opportunities for gainful employment both at on-farm and off-farm sectors are not increasing at a pace which can enhance the income of farm families. Under such unfavourable economic environment, young people do not like to take farming as a career.

Thus, a great challenge before the scientists and administrators is the identification and introduction of methods by which income and employment generation potential for farmers can be enhanced. At the same time the methods of lowering the cost of production needs to be standardized and this has to be done not by reducing the provision of essential inputs to the crop but evolving technologies that can reduce the cost of inputs used and also make their availability easier to the farmers besides finding ways to efficient biomass utilization, crop diversification value addition etc. Without the application of biotechnology economic sustainability is impossible to achieve.

## Conclusion

Apart from all this, introduction of GM crops into environment and food chain has been highly controversial. The main objections to the use of GM crops are the possible harm to human health and the environment. Some people believe that GM foods, containing genetically modified ingredients or enzymes, if released in large scale can displace the naturally processes and ecological balances and may bring nutritional changes, allergies etc; Thus, there is need of rigorous testing and GM foods should be given full safety assessment and even after testing, clear labelling should be there for consumers to make them clear about the choice whether to buy GM foods or the traditional ones.

However, despite the media hype, no real dangers related to GM foods have yet been documented.

In contrast "Arnold Donald" President of Monsanto's Crop Protection Unit says that biotechnology is leading to sustainable development of the planet.

Proponents also believe that biotech crops will boost productivity and can play major role in food security.

The advocates of GM Technology also believe that GM food will end up hunger and benefit consumers and would be appropriate to all environments as biotech crops are believed to have increased tolerance to chemicals, produce their own pesticides, develop specific characteristics, produce plants with faster rate of photosynthesis, high energy phosphate bond synthesis in chloroplasts, efficient electron transport, extract nitrogen from the air, adapt plants to harsher environments and produce better ingredients for food processing. Dr. Manju Sharma, Secretary DBT in a Biotech Conference (2001) has also said that "genetically in proved plants with insecticidal properties offer farmers an alternative to using pesticides".

However, the current initiatives in biotechnology in India, primarily an agricultural country with a predominant population of marginal and small farmers are unfortunately oriented to the needs of large scale commercial agriculture.

This warrants urgent intervention for re-directing the course of investigation towards subsistent and sustainable farming. Areas like improvement of nutritional quality and environment, crop diversification, value addition are required to be given priority for sustainable agriculture, besides giving attention towards the development of cash crops like Saffron, Olive , Zeera, Apiculture and Sericulture.

Again, the major share of biotech research has been seen in the public sector. With the result our marginal and small farmers are yet to reap the benefits of transgenic crops. But it can beneficially be utilized for catering to the needs of small/marginal farmers to curb their exploitation by 'Gene Giants' provided the cost factor of GM seeds/plants is resolved rationally to make it affordable to the farming community.

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# Intellectual Property Rights in Biotechnology

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Agriculture is of great importance to India as it contributes significantly to the overall growth of Indian economy. Recent innovations in biotechnology have led to a revolution in agriculture. A number of biotechnological applications have been adopted in recent years to increase the production of agriculture. With the advent of biotechnology, one of the issues is the legal characterization of new inventions. Thus, an important part of the biotechnology industry concerns patenting or intellectual property rights. Loosely defined, intellectual property (IP) is a product of the mind. Intellectual property is intangible in contrast to real property (land) or physical property, which one can see, feel and use. With any type of property there are property rights. When IPs are expressed in a tangible form, they can also be protected. Intellectual property rights (IPRs) have been created to protect the right of individuals to enjoy their creations and discoveries. In fact, IPRs can be traced back to the fourteenth century, when European monarchs granted proprietary rights to writers for their literary works.

IPRs have been created to ensure protection against unfair trade practice. Owners of IP are granted protection by a state and/or country under varying conditions and periods of time. This protection includes the right to : (i) defend their rights to the property they have created; (ii) prevent others from taking advantage of their ingenuity; (iii) encourage their continuing innovativeness and creativity; and (iv) assure the world a flow of useful, informative and intellectual works.

The convention establishing the World Intellectual Property Organisation (WIPO) in 1967, one of the specialized agencies of the United Nations System, provided that "Intellectual Property" shall include rights relating to

i. Literary, artistic and scientific works.
ii. Performance of performing artists, phonograms and broadcasts.
iii. Inventions in all fields of human endeavour.
iv. Scientific discoveries.
v. Industrial designs.
vi. Trademarks, service marks and commercial names and designations.
vii. Protection against unfair competition and all other rights resulting from intellectual activity in the industrial, scientific, literary, or artistic fields.

**Protection of intellectual property**

Intellectual property is protected and governed by appropriate national legislations. The national legislations specifically describe the inventions, which are the subject matter of protection and those, which are excluded from protection. For example, methods of treatment of the humans or animals by surgery or therapy, inventions whose use would be contrary to law or morality, or inventions which are injurious to public health are excluded from patentability in the Indian legislation.

**World Organizations**

| | |
|---|---|
| GATT | General Agreement on Tariffs and Trade |
| TRIPs | Trade Related Aspects of Intellectual Property Rights |
| WIPO | World Intellectual Property Organization |
| UPOV | International Union for Protection of New Plant varities |
| WTO | World Trade Organisation |

GATT was framed in 1948 and was meant to be a temporary arrangement to settle amicably among countries disputes regarding who gets what share of the world trade. GATT serves as a code of rules for international trade and a forum to discuss and find solutions to trade problems of the member countries. Agriculture was included for the first time in the 8th round of GATT negotiations in 1986, at Uruguay. The Uruguay round discussions were started in 1986, but successfully concluded on December 15, 1993. The negotiations were signed in the form of an accord on April 15, 1994 at Marrakesh, Morroco, by about 124 countries and led to the formation of World Trade Organization (WTO) on 1st January 1995. The Uruguay round covered 15 distinct areas and the Agreement on Agriculture (AoA) forms a part of the final act of the Uruguay negotiations.

The long term objective of the agreement is to establish a fair and market oriented agricultural trading system and that a reform process should be initiated through the negotiation of commitments on support and protection and through the establishment of strengthened and more operationally effective GATT rules and disclipnes. WTO is the rule based body for all trade and trade related issues. It seeks to reduce barriers to trade through mutually advantageous agreements. It differs from GATT and other bodies in that i) it covers all aspects associated with trade with binding rules for all the members, ii) it has a dispute settlement board and iii) it has a built in agenda for review.

WTO envisages a comprehensive scheme for protection of intellectual property rights and the establishment of a legitimate reward system for the creative inputs of the inventors of intellectual property under a broad category of Trade Related Intellectual Property Rights (TRIPs). Various articles under TRIPs cover different forms of IP viz. patents, trademarks, copyrights, designs, etc. All these forms of IP have a bearing on agricultural sector.

In 1961 at Paris, a "Union International Pour La Protection Des Obtentions Vegetables" UPOV-(International Union for the Protection of New Varieties of Plants) was signed for coordinating the intter-country implementation of PBR and it entered into force in 1968 with its headquarters based at Geneva.

**Forms of Protection**

Usually IPRs are protected by the following legal theories :

Patents
Copyrights
Trademarks
Trade secrets
Geographical indications
Designs
Layout designs of integrated circuits

Of these, patents are the most important forms of protection for research and development organizations. One of the most important examples of IP is the processes and products that result from the development of genetic engineering techniques. Another example of IP is the development of crop varieties, which are protected through Plant Breeder Rights or PBRs. Thus a better understanding of patents as the form of IP by research scientists and university/institute administrators will increase the pace of research for technological developments in biotechnology. Before describing the patents, the other forms of IP have been explained briefly.

### Copyright

Copyright protects only the form of expression of ideas, not the ideas themselves. The creativity protected by copyright law is creativity in the choice and arrangement of words, musical notes, colors, shapes and so on. Copyright was created to provide protection to composers, writers, authors and artists to protect their original works against those who copy; those who take and use the form in which the original work was expressed by the author. The best examples of literary, scientific and artistic works include productions such as books, pamphlets and other writings, dramatic or dramaticomusical works, choreographic works, musical compositions with or without words, cinematographic works, works of drawings, painting, architecture, photographic works, works of applied art, maps, plans, sketches, etc. Computer software/programme is another mode of expression . A computer programme is produced by one or more human authors but, in its final mode or form of expression it can be understood directly only by a machine (the computer) not by human readers.

In biotechnology, the copyright may cover DNA sequence data which may be published. However, an alternative sequence coding for same protein may be prepared using wobble in the genetic code, so that the copyright is not infringed.

The rights bestowed by the law on the owner of the copyright in a protected work are described as exclusive rights to authorize others to use the protected works. Copyright protection is generally valid in the country that grants the protection. Many countries respect the copyright of other countries, but if one wants protection in a certain country, it is best to apply for a copyright in that country. The agriculture industry uses copyright protection regularly. Directions on the use of a product and descriptions of product are few examples of copyright use.

In India, The Copyright Act 1957 as amended in 1999 is in force. The Copyright protection of computer software is under the IT Act 2000.

### Trademark

A trademark is a symbol that helps to distinguish one product or company from another. Symbols help the consumer identify products and/or a company and include designs, shapes, numbers, slogan, smell, sound or anything that helps the consumer to identify the products and/or companies.

In biotechnology research, laboratory equipments bear trademarks that are well known to workers in their field. Certain vectors useful in recombinant DNA technology are also known by their trade marks. Commercial names and designations constitute another catexgory of elements of intellectual property. Trade names are generally names, terms or designations that serve to identify and distinguish an enterprise and its business activities from those of other enterprises, whereas trademarks are used to differentiate between a company's product and all other products. For example slogan "Just Do It" identifies the Nike company.

Trademark law, unlike patent or copyright law, confers a perpetual right. So long as the trademark continues to identify a single source, anyone who uses a very similiar mark may be liable for trademark infringement. The perpetual right of trademarks depends on the use. The basic idea of 'use it or lose it' is essential to preserve trademark rights. A company cannot register a trademark and then not use it. The product for which the trademark was registered must be used commercially.

Trademark rights are so important that multinational companies spend large amount of money to maintain their respective trademarks around the world. Every country has different trademark laws. However, there are agreements to ensure that a company's trademark in one country is protected in another country. India has a Trade and Merchandise Act enacted in 1958 that has been amended in 1999.

**Patent**

A patent is a government granted exclusive right to an inventor to prevent others from practising i.e. making, using or selling the invention. A patent is a personal property which can be licenced or sold like any other property. In USA, once a patent is issued, a patent gives the inventor the legal right for 17 years to create a monoply by excluding others from creating, producing or selling the invention. In India, the Indian Patents Act of 1970 & 1999 amendment allows process patents, but no product patents for foods, chemicals, drugs and pharmaceuticals. In USA, a product patent is also allowed. If no product patent is available for a product, the same product may be manufactured by an alternative process without any infringement of the patent granted for the process. The duration of the patent in India is five years from the date of grant or 7 years from the date of filing the application, whichever is less for drug patents.

There are three criteria to issue a utility patent.

i. ***Novelty*** : The inventor must establish that the invention is new or novel. The novelty requirement refers to the prior existence of an invention. If an invention is identical to an already identical patented invention, the novelty requirement is not met, so a patent can not be issued.

ii. ***Inventive*** : It is invention and not merely discovery. It is non obvious to one skilled in the field. The non obvious requirement refers to the level of difficulty required to invent the technology. If the invention is so obvious that anyone having an ordinary skill would have thought of it, then it does not meet this requirement.

iii. ***Industrial Application*** : It has a utility or is useful for the society. The useful requirement refers to the practical use of invention. If the invention provides a product that is required or needed in some manner, then it meets this requirement.

In the patent adequate disclosure should be made so that others can also work on it. It should have the features : i) be a written description; ii) enables other persons to follow; iii) adequate and iv) deposit mechanism.

The purpose of a patent is to promote the progress of science and useful arts. The patent law promotes this progress by giving the inventor the right of exclusion. In exchange for this right to exclude others , the inventor must disclose all details describing the invention, so that when the patent period expires , the public may have the opportunity to develop and profit from the use of invention. A patent is enforced in the country which issues it. For each country a separate application is to be filed in that country where protection is sought.

### *Patenting of biological material*

Like in every other discipline, for biotechnology also, protection of intellectual property provides encouragement for creation of novel innovative technologies, involving genetic engineering. The general prerequisites for patentability, namely novelty, incentiveness and utility apply to biotechnology inventions as well. As a rule, any new biological material is patentable, if obtained through non-biological processes. Non-biological processes are defined as those where hand of man had a part to play.

***Microorganism patents*** : In the case of microorganisms, the first example was the classical judgement in the Diamond *Vs* Chakravarty case in 1980. In the Chakravarty case the US Supreme Court decided that a microorganism was not precluded from patentablity solely because it was alive. Thus a *Pseudomonas* bacterium manipulated to contain more than one plasmid (four plasmids were present) controlling the breakdown of hydrocarbons (therefore more useful in dispersing oil slicks than the natural organism containing only one such plasmid) was "a new bacterium with markedly different characteristics from any found in nature" and hence not nature's handiwork but that of inventor. The "product of nature" objection therefore failed and the modified organisms were held patentable. This precedent is being followed even today to define the patentability of microorganisms.

***Plant patents :*** Plant patents are also obtainable in US, Europe and Japan. The US Plant Patent Act of 1930 is restricted to asexually propogated plants and over 6,500 of such plant patents have been granted (mostly for rose and fruit trees). In the Hibberd case (1985), involving a tryptophan-overproducing mutant, the patent office ruled that plants could be patented. Following the principle established in the Chakravarty case, it was decided that normal US utility patents could be granted for other types of plant e.g. genetically modified plants. Among transgenic plants herbicide resistant cotton, canola, soybean etc. insect resistant potato, cotton, maize etc. have been patented. Plant patents have been granted by European Patent Office (EPO) from 1989. But in 1995, EPO severely restricted the scope of Plant Genetic Systems (Belgium) patent on herbicide resistant plants and allowed claims only on the herbicide resistant gene and the process used. In Japan, plant patents are allowed, but there are some disputes over territorial rights.

***Animal patents :*** Animal breeds produced by traditional methods have no legal system for their protection comparable to Plant breeder's rights. Based on the microorganism and plant precedents, the US Commissioner of patents declared in 1987 that the US patents would be granted for "non-naturally occurring non-human multicellular living organisms including animals". The first transgenic animal patent was issued in 1988 to Harvard university with claims covering the "oncomuse", one in which oncogene has been introduced to make the animal more susceptible to cancer and therefore more sensitive in testing possible carcinogens. After initial reluctance by the EPO to grant corresponding European patent (and a successful appeal to the Appeals Board), the European patent was issued in 1992. More than 300 patent applications for transgenic animals have been filed but so far few have been granted.

***Gene Patents :*** Patents on genes are available in all fields of biotechnology. For recombinant DNA inventions, the patent will claim the nucleotide sequence, coding for the protein expression product, vectors e.g plasmids containing this sequence, micro organisms transformed with the sequence and in appropriate cases the expression product itself (normally only if the product is new *per se*). Thus a gene or sequence itself is not patentable. If the gene sequence is identified and it has a function and is proved to be novel then it is patentable.

In India no life forms are patentable. In plant biotechnology, live plants (not the transgenic plants), naturally occurring microorganisms , micropropagation, tissue and organ culture techniques, biological control of pests or hybrid varieties cannot be protected using patents. Even techniques of cell fusion, protoplast fusion and gene transfer cannot be patented.

**Geographical indications :**

The geographical indications (GI) for the purpose of TRIPs agreement, have been described as indications which could be used to recognize that a good has originated in a particular territory, region or locality, where the given quality, reputation or other characteristic of the good are essentially attributable to its geographical origin. This is another way of protecting a country's biodiversity assets which are uniquely endemic to certain gergraphical locations in the country and has been accepted in terms of quality and traits to that geographical region is through appropriate national legislations. Products such as Scotch whisky, Champagne, California wines fall under this category. Recent instances of violations of possible geographical indications, is the case of basmati rice of India and Pakistan origin.

GI can be used, when protected in legal terms, to prevent others from misleading the public or creating unfair competition in trade for the goods that have their origin from a particular territory, region or locality. In the TRIPs there is an important provision that if some one uses a GI as a trademark and it misleads the public as to the true place of origin, then registration of trademark is refused or invalidated *ex officio.*

India enacted the Geographical Indications Act in 1999. Prior to that there was no specific law governing GIs of any agricultural, natural or manufactured goods including food stuff. India being party to the TRIPs agreement, was required to extend protection of GI for goods imported from other countries, which provide for such protection. A law to the effect in the country was necessary because other member countries would be obliged to give protection to the goods only if there are laws to protect the goods in the country of origin. The Indian GI Act 1999 means an indication in relation to goods, which identifies such goods (agricultural goods, natural goods or manufactured goods or any goods of handicrafts or of industry, including food stuff) as originating or manufactured in the territory of country or a region or locality in that territory as the case may be, where a given quality, reputation or other characteristic of such goods is essentially attributable to its geographical origin. GI cannot be a trademark, the only exception is that trade mark held prior to the Act or in good faith. According to GI an indication includes any name (excluding the name of origin country, region or locality), geographical or figurative representation or any combination of them.

**Trade Secret**

A trade secret is any information that gives a company a competitive edge over competitors and which the company maintains as secret and away from public knowledge. Trade secrets often include private proprietary information. For example, the Coca Cola company brand syrup formula, Polaroid company instant film chemical formula etc. The nature or the identity of a product is maintained secret for as long as the company can keep this information from becoming public knowledge.

Trade secret rights are mainly kept and enforced through agreements between employers and employees. These are non-patented. Usually at the time employment begins, an employer makes an employee sign an agreement which grants the employer trade secret protection. The agreements protect the company by preventing its competitors from enciting key personnel since these individuals cannot divulge the trade secret material without incurring severe penalities. Criminal prosecution of an employee who steals trade secrets from their employer is a recognized remedy. Trade secrets have an unlimited term which may be perpetual. The term is as long as it takes the public or a competitor how to make the products and to ascertain the nature ans identiy of the trade secret. Disclosure of a trade secret and its unauthorized use can be punished by court and the owner may be allowed compensation. However, if a trade secret becomes public knowledge by independent discovery or other means, then it is not punishable by court.

Trade secrets are much more common in industry where scholarly publication is not required . trade secrets in the area of biotechnology may includes (i) cells lines, (ii) gene transfer parameters; (ii) hybridization condition; (iv) corporate merchandising plan; (v) customer lists. However, biotechnological research being conducted in universities and institute are expected to share their findings through piblication and presentation in various conferences, it is almost impossible to maintain a trade secret.

**Designs**

The expression 'Design' means only the feature of shape, configuration, pattern or ornament applied to any article by any industrial process or means whether manual, mechanical or chemical, separate or comlined, which in the finished article appeal to end are judhed soley by the eye. Design menas the features od shapes etc. applied to an article and not the article itself. The features are conceived in the author's intellect. He gives those ideas conceived by him a material ( visual) form as pictorial illustration or as a specimen, prototype or model. By registration under . The Designs Act, 1911 has been amended in 1990 is in force in India, in which the features are protected as design. The act confers exclusive right to apply to any class in which the design is registered. To qualify for registration the design.

i It must be a new or original design.

ii It must not have been previously published in India.

**Layout designs of intergrated circuits**

Integrated circuit to pographies are the 3D configurations of electronic circuits embodied in integrated circuits, products or layout design. today they are at the heart of modern inforamtion, communication, entertainment, manufacturing, medical and space technologies . In India layout designs of the Intergrated Cirsuits are covered under the Semiconductor Intergrated Cirsuits layout Design Act 2000.

**Plant breeders rights**

Trade related intellectual property rights are among the major areas of concern to India as the Indian economic is agriculture based. Agriculture was included for the first time in the 8th round of Uruguay negotiations and accord was signed in 1994. TRIPS are copyrights, trademarks, trade secrets, designs, patents etc. Since agriculture was inculded in 1994 accord there is general feeling that enforcement of TRIPS will give rise to monoply conditions and in particular our agriculture sector will be influenced. Section 3b, Article 27, on 'Patentable Subject Matter" of TRIPS states:

Members may exclude from patentability

a. Diagnostic, therapeutic and surgical methods for the treatment of humans or animals.

b. Plant and animals other than microorganisms and essentially biological process production of or plants or animals other than non-biological and microbial process.

If the language of this provision is looked at critically, it would appear that all member countries are nfree to decide whether or not to treat plants and animals patentable . Depending upon its convenience, a member country can provide legal protection of plants and animals. In the USA plant varieties are protected under plant patent laws and also under the US patents and Trademark Laws. Thus, this article 27 and item 3b has the following implications:

a. It requires that microporganisms, non-biological processes and microbial processes must be patented.

b. Plant varieties must be protected by patents or patents or by an effective *sui generis* system or by any combination thereof.

Life forms are not patentable in India. For protection of plant varieties a *sui generis* system has been evolved. A *sui generis* system essentially means a system that is specially designed to protect plant varieties. The obvious model for this is the protection of Plant Breeders Rights.

In Indian Patent Art, 1970, all methods of agriculture and horticulture have beeen excluded from patentability. However, with the creation of WTO, it is incumbent upon member countries to have legal system in place to provide protection of plant varieties. India is thus required to met this obligation. Second amendment of India Patent Act 1970 has been done in 2002 that is much more compliant with TRIPS. The features are:

Product patent is to be taken up before 1.1.2005. Patent protection is possible for any new product or process.

Definition of the expression "invention" is now changed – means a new product or process involving an inventive step and capable of industrial application.

Non patentable aspects of the invention are specified (plants, animals in whole, seed varieties, mathematical, business method, a computer program *per se* or algorithms).

Invention , which in effect is traditionl knowledge or an aggregation of or duplication of known properties of traditionally known component(s) still not patentable.

Microorganisms *per se* can be claimed for protection provided they are not mere discovery of organisms.

Mandatory to deposit the biological material. Disclosure requirements prescribed for biological material for giving particulars of depository in the notified list of the central Government or for indicating its source and geographical origin.

Methods for rendering plants free of diseases can be clamied for paternting.
Products and Use patents to be made available.
Life of all patents will be 20 years.
Provision for compulsory licensing and licensing of rights more difficult.
Burden of proof for an infiringement to shift to alleged infringer, provided the products obtained by the defendant's process and the plaintiff's process are identical.

**Convention on biodiversity**

In June 1922, 170 countries met in Rio-de-Janerioa to discuss the details of a proposed Biodiversity treaty under the Biodiversity convention. Though US has not signed this treaty but this convention on Biodiversity (CBD) dealt with the sovereign rights of the nations over genetic resources. This CBD has come into force in December 1993 as the first legal mechanism dealing with resources. In respect of Biological Resources earlier status according to FAO international undertaking on plant genetic resources, a non –legally binding mechanism that had adhered to since inception in 1983 that 'plant genetic resources are the hertitage of mankind' and should be made available without restriction. But CBD which has come into force in 1993 as the first legal mechanism dealing with biological resources, these plant genetic resources are deemed not to be the heritage of mankind, but are the properties of the countries and are therefore tradable commodities. This is in contrast to protection of intellectual property rights, which decrees that natural products are the God's Gift to mankind, and hence, cannot be exploited exclusively by any one. The objective of the CBD, to be pursued in accordance with its relevant provisions include, i) the conservation of biological diversity, ii) the sustainable use of its components, iii) the fair and equitable sharing of the benefits rising out of utilization of genetic resources. The latter may include appropriate a) access to rightfully owned /possessed genetic resources, b) transfer of relevant rightfully held technologies, and c) funding.

Countries need to legislate Biodiversity bills ( protecting nature's treasure) the basic principle being , that no foreigner, or foreign organization could take away any biological resources for research or commercial use without permission of the country of origin. No local organization would be allowed to transfer even research results on biological resources to any foreigner without permission . The legislation will also ensure that benefits between conservers of the resources and users are equitably shared. Even though all the signatories had confirmed such approaches for protection of their soverign rights, most are yet to enact appropriate legislations in this regard. A week point in the CBD is its ambiguous treatment for the equity. It may be seen that whereas patenting of products of biotechnology is clearly recognized, but there are no effective guidelines and conditions defined to recognize and reward the contributions of indigenous communities and the other informal innovators who have been responsible for nurturing, using and developing biodiversity worldwide.

The key developments in India concerning legislative and regulatory provisions include the enactment of two legislations, on the protection of plant varieties and farmer's rights (PVPFR) and the other one on Biological diversity is The Biological Diversity Act 2002.

**Plant variety protection**

Trade related intellectual property rights (TRIPS) one of the agreements bound to the WTO, mandate the countries signatory to it, to put in place all legel and administrative changes required on IPR domains by January 2000 and 2005. Under this commitment, WTO member countries are required to grant patent to all inventions, whether processes or products, in all fields of technology ( including agriculture). TRIPS further demand India, as also any other member country, to grant patent to microorganisms, microbiological and non-biological processes and plants and animal produced by non-biological processes. Thus it implies that member countries should protect plant varities either by patent, or an effective system of *Sui generis* protection, or a combination of these two. In this contest India initiated its legislative process to protect plant varieties. Though all the three options i) patent, ii) *Sui generis* , and iii) patent and *Sui generis* were available, India chose a *Sui generis* system for protection of plant varieties . An Act named as plant Variety Protection and Farmer' s Rights ( PVPFR) 2001 has been passed.

The PVPFR Act 2001 provides protection to three types of plant varieties :

i) Newly bred varieties.

ii) Extant varieties – The varieties which were released under Indian Seed Act 1966 and have not completed 15 years as on the date of application for their protection.

iii) Farmer's varieties – The varieties which have been traditionally cultivated, including land races and their wild relatives which are in common knowledge, as well as those evolved by farmers.

The PVPFR Act is notable for farmer's rights and intergration of the some of the important elements of CBD, such as prior informed consent for the use of Indian genetic resources, the concept of benefit sharing and creation of gene fund for strengthening agrobiodiversity conservation. The farmers right in this act provides right to register farmers varieties, right to claim compensation for under performance of a protected variety from the promised level, benefit sharing for use of biodiversity conserved by farming community, protection from legal proceedings of any alleged infringement. According to the concept of benefit sharing, whenever a variety submitted for protection is bred with the possible use of a land race, extant variety or farmer's variety, a claim can be referred either on behalf of the local community or institution for a share of the royalty.

# On-Farm PHT and Value Addition for Sustained Agricultural Production in WTO Context

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## ABSTRACT

Agriculture provides sustenance to two-third of India's population which has crossed 1 billion and still growing. Vastness of India and agro-climatic diversity enables it to produce wide range of crops and commodities. It has succeeded achieving quantum jumps in production and productivity of almost all crops and animal products. Large domestic market, science & technology base, trained human resource, trade and industrial infrastructure are its assets. But it has constraint of water and population pressure. globalisation of the world market and India joining GATT and subsequently signing WTO agreement offers opportunities as well as poses threats. Indian agriculture has been basically subsistence farming practiced on small and marginal farms. Green, White, Yellow and Blue Revolution have set trend towards modernized agriculture and given the country confidence not only to meet its own needs but also export. Sluggish growth in manufacturing sector has drawn attention of industry towards export of agricultural commodities and processed products. This demands quality, hygiene and food safety norms of the importing countries being met. Growing middle classes, husband & wife both working is increasing domestic demand for processed products. There are countries, developed and developing, that are looking for Indian market under WTO. If Indian farmers and processors don't acquire competitive edge, the terms of trade could be negative and thus loss of income and employment opportunities. Rural India is already at disadvantage with agricultural GDP on declining trend, steady decline in size of land holding,rising cost of living and under WTO Governments obliged to reduce subsidies. In such a scenario Indian farmers have to be trained, their skills and technologies improved, inputs and services provided such that not only their productivity goes up with reduced unit cost of production but their produce meet global sanitary and phytosanitary norms, efforts are on to this effect. However,

increased production and productivity does not mean more net returns to the grower in the absence of appropriate PHT and agro-processing and marketing. Agricultural produce and by-products are perishable in nature and their perishability gets exploited in the market leading to distress sales. Post-Harvest losses continue to be excessively high- about 10% in foodgrains, 20-40% in fruits and vegetables, 10-12% in animal products aggregating to over Rs. 80,000 crores per annum that can be easily minimized to half, a penny saved is penny earned. Added capacity to the rural sector will enable them to retain their produce and by-products with least losses and help negotiate with the forces of marketing, meet their own needs with minimum cost, by-products of agro-processing valued as food, feed , fuel, fibre, plant nutrients and industrial raw materials can be gainfully utilized in the rural sector to economic advantage. They will be able to add value to their marketable surpluses and earn more. Thus, on-farm PHT and value addition will become an instrument of socio-economic development of the rural people through additional income and employment. In this direction State Agricultural Universities and ICAR Institutes have to play proactive role through HRD and bringing stakeholders for required inter-play transforming rural India from more producer of raw material to producer-cum-primary processor.

## 1. Introduction

Agricutlure continues to be the backbone of Indian economy in that two-third of its population draws sustenance from agriculture and agriculture and allied activities contribute 25% to its GDP. However, with decreasing share of agriculture to GDP is resulting into rural poverty and people are faced with the livelihood problem. The rural poverty and livelihood issue is aggravated by rising standards and cost of living at one end and on the other shrinking land holdings, steadily rising input costs, globalization and associated liberalisation of markets and demand of competitiveness in unit cost of production, quality and ability to market produce and primary processed products without excessive post-harvest losses. Factors of demand and supply, poor PH-infrastructure, markets and the forces that intervene the agriculture markets usually create slump in the market price whenever there is a bumper harvest of any crop or commodity. Orchestrated distress sales, denying growers remunerative prices, compels the farmers to shift over to other crop and commodity which in turn creates scarcity and soaring consumer prices. A vicious cycle that does not seem to be ever ending to the detriment of growers and consumers' interest.

During the colonial periods the reasonably self-sufficient rural Indian got reduced to just producer of raw material. At the wake of industrial revolution engine and motor operated processing industries rendered the traditionsl agro-processing units, run by animate power sources, non-competitive. So much so that rural people were obliged to buy from the market items of daily necessities through the traders and retailers, a practice that continues till date to a great extent, making unfavourable terms of trade worst for the rural people. Growers have no share in value-addition to their produce and by-products. Large part of year their family labour is un or under employed. Landless often migrate in search of wage earning dislocating education of children. It has brought post-harvest technology and agro-processing at the centre stage. Scientists, policy markers and development agencies are looking towards rural food and agro-processing as a tool for additional income and employment to the rural people enabling them to meet their needs at the least cost, retain and use waste and by-products usually of feed, fuel and industrial raw material value in the production catchment and market surpluses after value addition. Leading luminaries of Indian agriculture consider PHT and Value Addition as half the agriculture story.

Food and agro-processing is not something new. It has existed all along with human civilization and progressively advanced with it. In modern times it has emerged as a multi-disciplinary area of academics, research and development. Some 3000 years BC, the hunter gatherers tranformed themselves in to farming-cum-semi-pastoral livestock husbandry society, after they learned to domesticate plants and animals. They were remarkable people who invented tools and implements of farming using men and draft animals, irrigation, transport, storage, primary processing etc . They advanced in to urban society that had well laid out roads, houses made of burnt clay with utilities, community facilities, centres of storage and agro-processing, crafts, learned trade and commerce and went as far as Mesopotamia. What a resilience of the technology developed, their inventions have maintained continuity-harnessing of draft animal, Desi Hal, runoff and river waters for irrigation, bullock-carts, sail boats, domestic and community grain storages, mortar-pestle, use of solar and wind energy for crop conditioning, cooking stoves, ovens, pots and pans etc. It was enriched during vedic periods and by Baudh and Jain traditions when iron became principal metal for farm equipment. Advancements in metallurgy and craftsmanship during medieval periods made process and equipment more refined, more long lasting but the basic concepts and operative principles survived. They contributed to enrichment of material culture and to socio-economic advancement of the succeeding generations till the modern times.

There is convergence of thoughts at different levels that in order to assure remunerative prices to the growers, make available consumers food and agro-products at affordable prices, the development and application of appropriate post-harvest technologies, food and agro-processing industries located in rural areas in production catchments and as far as possible owned and operated by targeted beneficiaries, individually or collectively, is a must. It has greater capacity for employment and income generation than production agriculture. It can help stabilizing market prices through removing vulnerabilities of perishables by transforming them in to semi-perishables or durables or through appropriate post-harvest infrastructure hold the perishable agricultural commodities for table use.

"Urbanization" has come to be a developmental goal in order to improve lot of the rural people.

There are production and productivity related issues constraints too that impede acceleration in agro-processing and value addition activities. Many of our crop varieties are tailored for table grade use, when used for processing the product recoveries tend to be low, much lower than the strains and varieties available with the world leaders. Crop scientists under NARS are now addressing to it. Under standard crop management i.e prescribed input use conditions our productivities are 'next to none' for all practical purposes. Rainfalls in India are largely unimodal concentrated in just a few months. Crops have to be irrigated which means additional cost. Studies under AICRP on Energy Requirement in Agriculture of the ICAR, have shown that under irrigated farming, irrigation and fertilizer are the two most energy intensive unit operations which means higher cost of production. Whereas most of USA, Europe, Australia etc have well spread rains, easy to practice rainfed farming with high doses of fertilizers to achieve high yields and remain competitive.

## 1.1 Supply chain of Agricultural Commodities:

Supply chain of agricultural commodities is varied. There could be 6-10 hand exchanges before a primary processed commodity like dal or vegetable oil may reach to the rural consumer. About 3-5 hands exchange in gathering, storage and transporting agriculture produce to the millers and another 3-5 hand exchange before the milled product is purchased by the consumer. Each may be adding 5-10% to the cost to be paid by the consumer. The consumer pays heavily and the the producer usually obliged with non-remunerative prices but a thriving chain of middlemen. No doubt in PHT there is room for middlemen as service agent but not to take away lion's share of value addition. As of now, the farmers also take risk of farming besides putting in their land, labour and capital have hardly share in value addition. Horicultural commodities as generally consumed fresh, in India; a typical suppy-chain is at Fig. 1. To give benefit of PHT to producers as well as consumers National Dairy Development Board (NDDB) evolved a management model jettisoning the middlemen (Fig 2). This model is working successfully for milk and dairy products.

## 1.2 On-Farm Post-Harvest Management:

Basic goals in on-farm post-harvest management of agricultural produce and by-products are primarily to create capacity that enables safe handling of produce from the stage the crop or commodity is ready for harvest, avoiding qualitative and quantitative losses at affordable cost, process, package and transport, to remunerative markets, hold the produce safely in the event of distress sales, better still add value to produce and by-products before marketing through agro-processing enterprises for additional income and employment. Thusspecific goals of On-Farm PHT and post-harvest management are

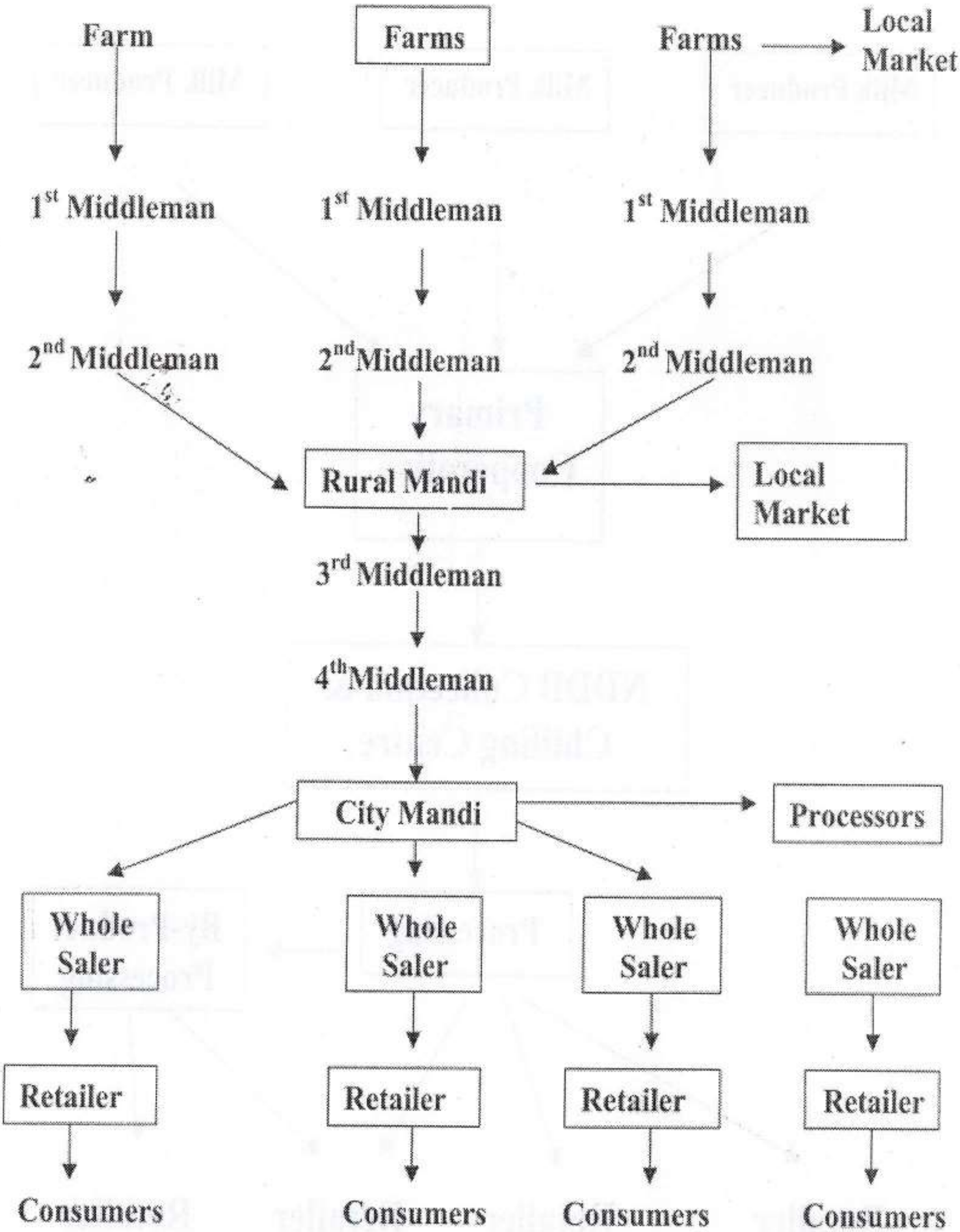



**Fig. 1 Existing supply chain (F&V)**

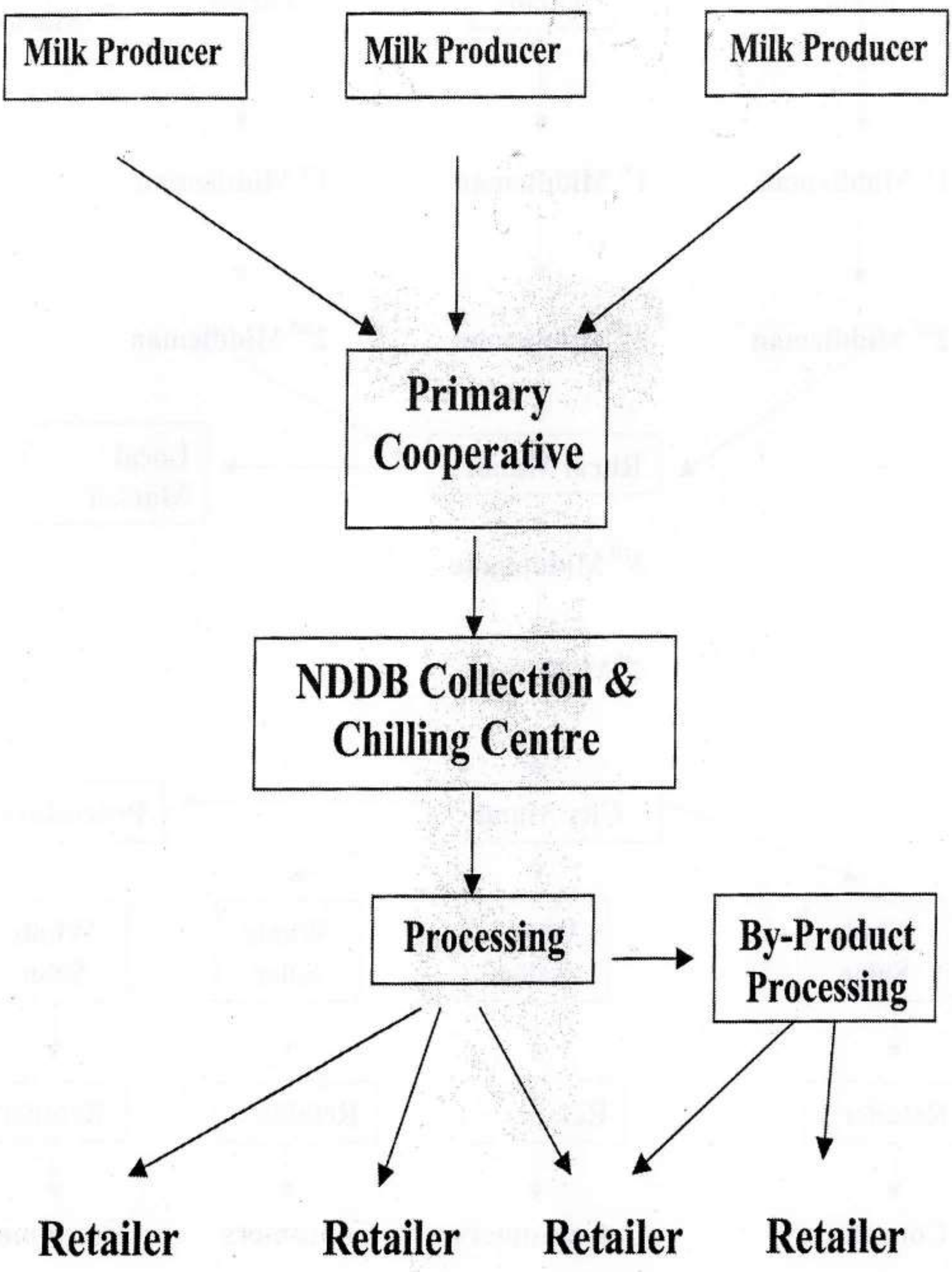



**Fig. 2 National Dairy Development Board**

- Minimisation of harvest and post-harvest losses, improving net availability and net returns to the growers.
- Capacity to handle and hold the produce without excessive losses at affordable cost to negotiate with the forces of marketing avoiding distress sales.
- Transform the perishables in to semi-perishables or durables for better marketing and also value addition.
- Creation of rural agro-processing enterprises that meet needs of the rural people at the least cost and market surpluses after value addition for additional income and employment.
- Improve livelihood base of rural people through entrepreneurship development and upgradation of skills.
- Provide consumers fresh and processed products at reasonable rates.
- Make better use of crop residues, processing of by-products and wastes in eco-friendly and economically rewarding fashion.
- Meet hygiene and quality standard specified for domestic and export markets for fresh and processed products.

## 1.3 Unit operations of PHT:

The major operations involved in on-farm post- harvest management include cleaning, grading, drying / dehydration, dehulling, decorticating, splitting, shelling, peeling, grinding / milling, polishing, extraction/ expression, curing, treatment, handling, blending, packaging, storage, transportation, dispensing and marketing etc. Agriculture commodities are perishable and their biological activities continue even after harvest. Post-harvest physiology of the commodity play important role in post-harvest management. These are vulnerable to attack from insects, microbes and other pests. If not handled properly lot of qualitative and quantitative damages can take place. There are large number of post-harvest equipments indigenously manufactured and used (Table 1)

**Table 1: Present status and future projections of some of the post harvest equipment in India**

| Name of equipment | Number in 1991 | Number in 2000 |
|---|---|---|
| Cleaners & graders | 1,10,000 | 2,90,000 |
| Dryers | 7,000 | 25,000 |
| Maize shellers | 65,000 | 1,15,000 |
| Flour mills | 2,66,000 | 3,50,000 |
| Rice mills | 1,25,000 | 1,50,000 |
| Dal mills | 10,000 | 25,000 |

| | | |
|---|---|---|
| Groundnut decorticators | 1,50,000 | 3,80,000 |
| Oil seed processing units | 2,25,000 | 4,50,000 |
| Fruits & vegetables processing units | 400 | 600 |
| Total | 9,58400 | 17,85,600 |

## 2. Status of PHT and Food and Agro-Processing Industry

India's food processing mainly involves primary processing which accounts for 80% of the value. As much as 42% of the food industry is in the organized sector and 33% in the small scale, tiny and cottage sector which are beset with problems of inefficiencies of high cost, scale dis-economics and inadequate logistic support. According to a CII-McKingsey report the size of India's food industry estimated as Rs 2,50,000 crore is expected to double by 2005. Of this, value added processed foods are forecast to rise three times from the present Rs 80,000 to 2,25,000 crore during the same period. This should give a fair idea of opportunities for employment generation.

Under National Agricultural Research System (NARS) including ICAR Institutes and State Agriculture Universities, a large number of equipment and technologies have been evolved which have also been rigorously evaluated and many of them are already commercialized. Apart from these Instititions, other research and development organizations, cooperatives and also industrial sectors have also evolved many useful technologies and have come out with the agro processing models. However, many of the organized sector processing plants are imported on turn-key basis not necessarily most modern.

Food items are marketed and utilised at different stages - (a) raw (fresh), (b) primary processed, (c) secondary processed and (d) tertiary processed (Fig. 3). Technology intensity index (TII) of a country's food industry can be computed knowing the proportion of the above categories on a scale 0.25 to 1.00. When the food industry is predominated by activities related to simple food conservation measures TII value is 0.25 and where value addition is maximised the corresponding figure is closer to 1.00. A number of parameters are considered to monitor status of Food Industry Development Index (FIDI). A FIDI value of below 400 indicates relatively weak food industry, a value between 400-600 reflects reasonably strong industry and above 600 very strong. FIDI value for India is 415.

### 2.1 Pre-Harvest Bearings on Post-Harvest:

Crop and commodity selected for agro-processing should be well understood in term of its varietal characters, cultural requirements, expected yields and milling recoveries. Post-harvest characteristics of an agricultural produce is affected by preharvest treatments - seed rates, level of fertilizer use, nutritional balance, irrigation and drainage, attack of diseases and pests, growth hormones and pesticides used and their residual toxicity, mechanical and environmental injuries during harvesting, handling, transport and storage.

Number of studies have been undertaken on this aspect under NARS but would be called still inadequate.

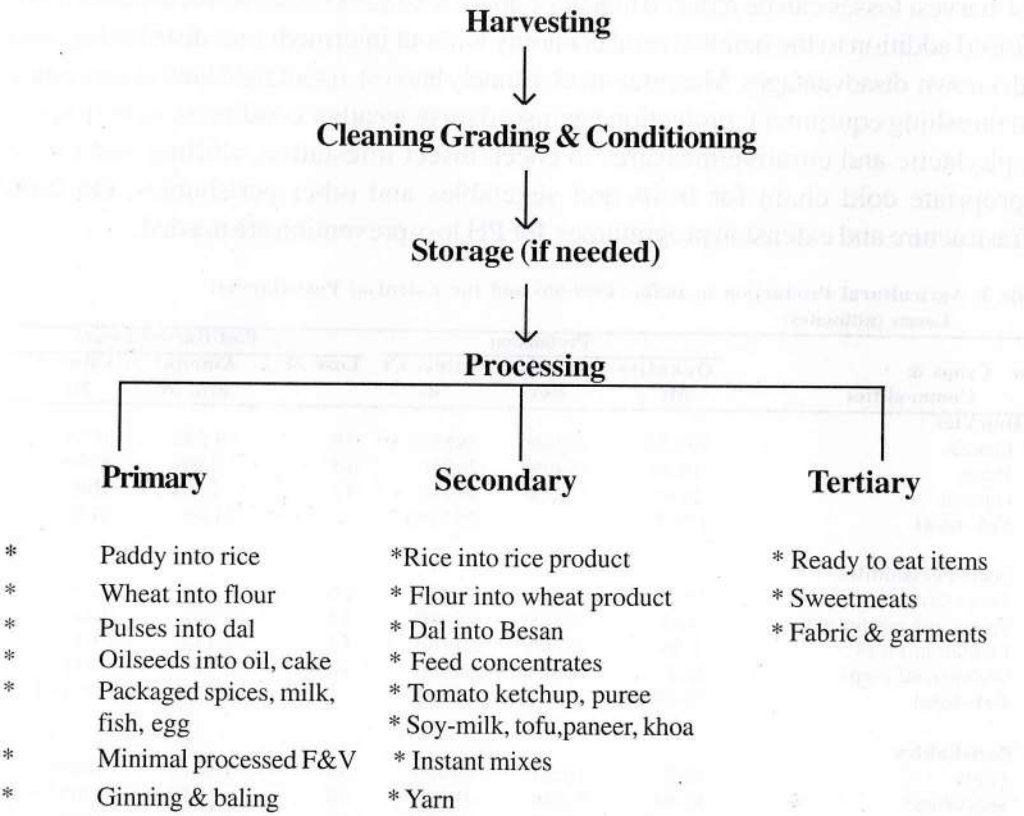



**Figure : 3 Agricultural Processing**

Rice raised on excessive doses of N tends to give low recovery in raw milling but parboiled milling removes this defect to a great extent. After physiological maturity most of the foodgrains and oilseeds dry rapidly, however failure to harvest timely results in to excessive shattering, losses in milling and increased chances of discolouration, mold and fungi attacks in the event of untimely rains & over cast weather. Strong awareness derive is needed. Harvest of fruits and vegetables at times advanced depending upon transport and distribution time.

## 2.2 Post-Harvest Losses:

Harvest and post -harvest losses are excessive (Table 2). About 10-12% of the foodgrains, 20-40% of fruits and vegetables, 10-12% of milk, meat, poultry and fish amounting to about Rs 87,000 crore are lost every year. With the available technologies post-harvest losses can be reduced to half i.e about Rs 43,500 crore worth decentralised, diffused addition to the national rural economy without intermediaries distributing cash with known disadvantages. Measures involve timely harvest, use of right kind of harvesting and threshing equipment, protection against adverse weather conditions, safe storage, prophylactic and curative measures to check insect infestation, chilling and use of appropriate cold chain for fruits and vegetables and other perishables. On-farm infrastructure and extension programmes for PH loss prevention are needed.

**Table 2: Agricultural Production in India (1999-00) and the Extent of Post-Harvest Losses (estimates)**

| SNo. | Crops & Commodities | Production: Quantity Mt | Production: Av. price Rs/t | Production: Value, Cr Rs | Loss, % | Post-Harvest Losses: Amount lost, Mt | Post-Harvest Losses: Value, Cr Rs |
|---|---|---|---|---|---|---|---|
| **A.** | **Dumbles :** | | | | | | |
| 1 | Cereals | 195.52 | 10,000 | 195520 | 10 | 19.552 | 19552 |
| 2 | Pulses | 13.36 | 15,000 | 20040 | 15 | 2.004 | 3006 |
| 3 | Oilseeds | 20.87 | 20,000 | 41740 | 12 | 2.504 | 5009 |
| | **Sub-total** | 229.75 | | 257300 | | 24.06 | 27567 |
| **B.** | **Semi-Perishables** | | | | | | |
| 4 | Tuber Crops | 32.19 | 5,000 | 16095 | 20 | 6.438 | 3219 |
| 5. | Spices and condiments | 3.02 | 40,000 | 12080 | 12 | 0.362 | 1449.6 |
| 6 | Plantation crops | 9.28 | 45,000 | 41760 | 12 | 1.114 | 5011.2 |
| 7 | Commercial crops | 33.8 | 15,000 | 50700 | 10 | 3.38 | 5070 |
| | **Sub-total** | 78.29 | | 120635 | | 11.294 | 14749.8 |
| **C.** | **Perishables** | | | | | | |
| 8 | Fruits | 45.5 | 10,000 | 45500 | 30 | 13.65 | 13650 |
| 9 | Vegetables* | 58.64 | 8,000 | 49912 | 30 | 17.592 | 14073.6 |
| 10 | Milk | 78 | 12,000 | 93600 | 12 | 9.36 | 11232 |
| 11 | Meat | 4.46 | 50,000 | 22300 | 12 | 0.535 | 2676 |
| 12 | Fish | 5 | 45,000 | 22500 | 12 | 0.6 | 2700 |
| 13 | Egg | 2 | 20,000 | 4000 | 12 | 0.24 | 480 |
| | **Sub-total** | 193.6 | | 237812 | | 41.977 | 44811.6 |
| **Total** | | 501.64 | | 615747 | | 77.331 | 87128.4 |

## 2.3 Crop Conditioning and Storage

### 2.3.1 Cleaning and Grading:

Bold size grains, fruit and vegetables fetch premium price. Higher price is there for produce free from chaff, brokens, immature, shrivelled, weather damaged, stones and other foreign matters. Stone free clean rice, Dal, Suji, instant mixes, ready to cook items are in demand. Small and marginal farmers and landless can use their surplus labour for such value addition activity for at home or door to door custom service.Likewise fruit cleaning, grading packaging manually or using packaging line can be source of additional income and employment generation. A number of cleaners and graders have been developed under NARS (Table 3,4).

### 2.3.2 Shelling and Decortications:

On - farm dehusking, shelling and decortication add value to the produce; reduces handling, transport and storages costs, at the same time make the product more presentable in the market in the form preferred by the consumer/buyers. As number of manual and power operated dehuskers, shellers and decorticators have been developed and are available in the market ( Table5) . These need to be popularized.

### 2.3.3 Drying

Drying and dehydration are lowcost and effective methods practised all over the world to protect produce and by-product from moisture damage or transform them in to value added products using sun, shade, heated air, or heated surface drying methods. There are numerous designs of dryers in different capactis avaiable suiting to different applicaions . Leaving a few batch, and recirculatory grain dryers and tray dryer for fruit and vegetable dryer used in mills and processing plants, mechanical dryers are not in use, though there is considerable damage, discolouration to foodgrains and oilseed due to excess moisture . Occurrence of mycotoxins due to excessive moisture in hot and humind zones cannot be ruled out. A number of dryers have been developed under NARS ( Table 6,7) . Dryer need to be extended for on -farm and market level use. Commonaly dehydrated products are prunes and resins, chillies, peas, okra, potato flour, banana chips, cassava chips, green and ripe mango slices leather, badi etc.

### 2.3.4 Storage

Scientific storage - room ,wearhouse storage bins, or CAP storage give capacity to the growers to negotiate with the forces of marketing and earn 25-20% higher easily. Beside improved domestic storages like Hapur Kothi safely store foodgrain at domestic level and allow fumigation in the event of infection . AICRP on Post- Harvest Technology has developed low cost on farm storage structures

**Table 3: Grain Cleaners and Graders Developed under NARS**

| Particulars | Manual Double Screen cleaner | Pedal Operate Air Screen Grain Cleaner | Paddy Winnower | Seed Cleaner-cum-Grader | Single Drum Rotary Screen Pre-Cleaner |
|---|---|---|---|---|---|
| Developed by | CIAE, Bhopal | CIAE, Bhopal | TNAU, Coimbatore | TNAU, Coimbatore | PAU Ludhiana |
| **Specifications:** | | | | | |
| * Type | Manual,cradle type, 2-screen | Pedal operated blower, 2-screen | Power operated | Power operated reciprocating | Power operated rotary screen |
| * Dimentions | 900x600x140 | 1600x500x1000 | 1210x960x1430 | 1800x1200x1800 | 1525x115x1730 |
| * Weight, kg | 14 | 100 | - | | |
| **Test Results** | | | | | |
| * Suitability | Foodgrains and oilseeds except groundnut | Foodgrains and oilseeds except groundnut | Paddy and other grains | Paddy and other foodgrain | Wheat, paddy |
| * Capacity | 150-225 kh/h | 350-600 kg/h | 750 kg/h | 20 q/h paddy & pearlmillet 32-34 q/h maize & sorghum | 12-15 q/h |
| * Cleaning/ grading off, % | 99-99.8 | 99.5-99.9 | 97 | 92 | 95 |
| * Labour | 1 | | 2 | 2 | 2 |
| * Power | Manual | | 1 hp motor | 2 hp motor | 1.5 hp motor |
| **Economics:** | | | | | |
| * Capital cost, Rs | 1000 | 10,000 | 20,000 | 50,000 | 20,000 |
| * Unit Cost of operation Rs/q | 2-3 | 2-3 | 2-3 | 3-4 | 0.5-1.0 |



Contd

Table 3- Contd.

| | | | | | |
|---|---|---|---|---|---|
| * Working Capital, Rs. | 1000-2000 | 2000-5000 | 2000-5000 | 5000-10000 | 5000-10000 |
| * Return on investment, % | 40-50 | 40-50 | 25-30 | 25-30 | 30-40 |
| * Pay back period, y | 2-3 @ 45 d/y | 2-3, @ 45 d/y | 3-4, @ 30 d/y | 3-4 @ 30 d/y | 3-4 @ 45 d/y |
| Stage of exploitation | Commercial | Commercial | Commercial | Commercial | Commercial |
| **Source of availability** | 1. CIAE Bhopal<br>2. M/s Bindu Agro-Ind Plot 73, Sector H, Govindpura, Bhopal | 1. CIAE Bhopal<br>2. M/s Bindu Agro-Ind Plot 73, Sector H, Govindpura, Bhopal | TNAU Coimbatore | TNAU Coimbatore | 1. PAU Ludhiana<br>2. M/s Hindsons Pvt Ltd, Lower MAU Patiala |

# TABLE 4

## Table 4 : Grader for Horticulture Crops, Groundnut

| Particulars | Groundnut Grader | Apple Grader | Potato Grader | Weight based Friut Grader | CIPHET Fruit Grader |
|---|---|---|---|---|---|
| Developed at | TNAU,Coimbator | GBPUAT, Pantnagar | PAU Ludhiana | GBPUAT, Pantnagar | CIPHET Ludhiana |
| **Specifications:** | | | | | |
| *Type | Power Operated, slotted oscillating sieve | Power operated differential speed expanding pitch v-belts | Power operated expanding pitch rubber-spool | Power operated weight based grader | Size based, expanding pitch rollers, 6-8 grades |
| *Dimensions | 2250x 1050x 1350 | 4900x 1500x1340 | 5200x1640x1690 | 1500x1500x 1200 | 3000x 2000x1500 |
| *Weight,kg | | 500 | 550 | 70 | 200 |
| **Test Results:** | | | | | |
| *Suitability | Groundnut | Apples,potatoes | Potato,apples,citrus | Round shaped Fuits,25-225mm diameter | Kinnow, citrus.other round fuits 50-250 mm diameter |
| * Capacity, q/h | 6 | 15 | 15 | 3-4 | 10-15 |
| * Labour | 2 | 2 | 2 | 2 | 3-4 |
| *Power | 1hp motor | 2 hp motor | 1hp motor | 1hp motor | 2 hp motor |
| **Economics:** | | | | | |
| *Capital cost Rs | 20,000 | 30,000 | 40,000 | 15,000 | 35,000 |
| *Unit Cost of operation Rs/q | 2-3 | 1-2 | 3-4 | 10-15 | 10 |
| *Working Capital, Rs | 2000-3000 | 5000-10000 | 5000-10000 | 2000-5000 | 5000-10,000 |
| *RI,% | 25-30 | 35-40 | 35-40 | 50-60 | 50-70 |
| *Pay back period,y | 3-4,@30-40 d/y | 3-4,@30 d/y | 3-4,@30d/y | 1.2-2.0, @45-50 d/y | 1.5-2.0 |
| **Stage of exploitation** | Yet to be commercialized | Yet to be commercialized | Yet to be commercialized | Released commercial production | Commercial |
| **Source of availability** | College of Agric Engg TNAU, Coimbatore | GBUAT,Pantanagar | 1.College of Agric Engg PAU,Ludhiana 2. M/s Universal Farm Machinery Corpn,Patiala Road , Nivwarna Jind (Haryana) | College of Technology, GBPUAT, Pantnagar | M/s Regency Agro Pvt. Ltd., Malout(Pb) |

**Table 5 : Dehuskers , Shellers and Decorticators Developed under NARS**

| Particulers | Manual Coconut Dehusker | Tabular Maize Sheller | Manual Groundnut Decorticator | TNAU Arecanut Dehusker | TNAU Groundnut Decorticator |
|---|---|---|---|---|---|
| Developed at | CPCRI, Kasargod | CIAE,Bhopal | CIAE,Bhopal | TNAU, Coimbatore | TNAU, Coimbatore |
| **Specifications:** | | | | | |
| *Type | Manual, piercing type | Manual | Oscillating soeconcave, manual batch | Power operated rotor-concave coninous | Power operated Osci-drum-concave,continous |
| *Dimensions mm | 680x275x1980 | 72x65 | 250x500x1100 | 1560x660x1600 | 1320x450x1380 |
| *Weight,kg | -- | -- | -- | -- | 195 |
| **Test Results:** | | | | | |
| *Suitability | Coconut | Maize | Groundnut, castor | Dried arecanut | Groundnut |
| * Capacity, q/h | 150 nuts/h | 15-20 kg/h | 40-45 kg/h pods | 100 kg/h | 260 kg/h |
| * Labour | 1 | 1 | 2 | 1 | 2 |
| *Power | Manual | Manual | Manual | 1 hp motor | 1 hp motor |
| * Shelling(eff %) | 100 | 100 | 100 | -- | 95-8 |
| **Economics:** | | | | | |
| *Capital cost Rs | 3,000 | 25 | 800 | 15,000 | 15,000 |
| *Unit Cost Rs/q | 15 | 30 | 50 | 20 | 10 |
| *Working Capital, Rs | 500-1000 | Negligible | 2000-3000 | 5000-8000 | 5000-7000 |
| *RI,% | 40-45 | 100 or more | 50-60 | 40-50 | 30-40 |
| *Pay back period,y | 2-3, @ 150 d/y | 10-12 days of operation | 1.5-2.0 y @30-40 d/y | 2-2.5 y @150 d/y | 2.5-3.0 @ 150 d/y |
| **Stage of exploitation** | Commercial | Commercial | Commercial | Yet to be commercialized | Commercial |
| **Source of availability** | CPCRI,Kasargod | 1. CIAE, Bhopal 2. MP Agro-Ind., Bhopal 3. M/s Bindu Agro-Ind., Bhopal | 1. CIAE, Bhopal 2. MP Agro-Ind., Bhopal 3. M/s Bindu Agro-Ind., Bhopal | TNAU,Coimbatore | TNAU,Coimbatore |

Table 6: Food Grain Dryers

| Particulars | Community Grain Dryer | Heated Sand grain Dryer | Batch Dryer | Continues Grain Dryer |
|---|---|---|---|---|
| Developed by | CRRI cuttack | TNAU, Coimbatore | TNAU, Coimbatore | GBPUAT,Pantnagar |
| Specifications: | | | | |
| *Type | Recirculating batch, Solar-cum-rice husk | Continuous flow | Batch, forced convention | Continuous, cross flow |
| *Dimensions | 1200 diax2500 | 3320x1230x1710 | 22901700x1100 | 1260x1220x3300 |
| Test Results: | | | | |
| *Suitability | Paddy | Drying paddy and roasting of legumes | Paddy, pearlmillet, sorghum,groundnut | Paddy,wheat, maize,pegionpea and other foodgraom |
| * Capacity | 1 t/batch | 0.6-0.8 t/8h | 0.5-1.0t/8h | 0.8-1.0t/h |
| * Labour | 2 | 1 | 1 | 2 |
| *Power | 5hp motor | 3 hp motor | 2 hp motor | 3 hp motor |
| * Heat | Solar, rice husk | Fuelwood @10-12 kg/h | LDO,kerosene or crop residues | 18 kwh electric heaters |
| Economics: | | | | |
| *Capital cost Rs | 1,00,000 | 30,000 | 40,000 | 50,000 |
| *Unit Cost Rs/q | 20-25 | 40-50 | 50-60 | 30-40 |
| *Working Capital, Rs | 1-2 lakh | 50000-75000 | 20000-30000 | 0.5-1.0 lakh |
| *RI,% | 25-30 | 25-30 | 25-30 | 30-35 |
| *Pay back period,y | 3-4@150 d/y | 3-4@ 200 d/y | 3-4 @ 100 d/y | 3-4 @150 d/y |
| Stage of exploitation | Yet to be commercialized | Yet to be commercialized | Yet to be commercialized | Yet to be commercialized |
| Source of availability | CRRI Cuttack | TNAU,Coimbatore | TNAU,Coimbatore | GBPUAT,Pantnagar |

Table 7: Solar Dryers for Crops and Commodities

| Particulars | Solar Cabinet Dryer | CPCRI Solar Dryer | Low cost Poly Solar Dryer | Solar Fish Dryer |
|---|---|---|---|---|
| Developed by | CIAE, Bhopal | CPCRI, Kasargod | CPCRI,Kasargod | CIFT,Cochin |
| Specifications: | | | | |
| *Type | Natural convection trays,prtable | Cabinet, natural convection | Cabinet, natural convection | Batch, forced convection,solar flat plate air heater |
| *Dimensions mm | 2260x1440x2410 | 1350x950x7000 | 1150x900x600 | 8000x5000x2000 |
| Test Results: | | | | |
| *Suitability | Chilli, potatochips/cubes, cauliflower leafy vegetables | Coconut,arecanut, pepper,cardamom | Coconut, pepper,fish, papad etc. | All Kind of fish |
| * Capacity | 30-50 kg/batch | 80-100 coconut 50 kg arecanut, 18kgpepper/batch | 60 nuts/batch | 40 kg/batch |
| * Labour | 2-3 man h/d | 1-2 man h/d | 1 man h/d | 2-3 man h/d |
| *Power | - | - | - | 1 hp motor |
| * Heat | Solar | Solar | Solar | Solar |
| * Drying time d/batch | 1-5 | 4 coconut, pepper 30 arecanut | 6 batch of 60 nuts | 2 |
| Economics: | | | | |
| *Capital cost Rs | 8000 | 4000 | 500 | 50,000 |
| *Unit Cost of drying, Rs/q | 200-250 | 200-300 | 300-400 | 300-400 |
| *Working Capital, Rs | 2000-3000 | 2000-3000 | 2000-3000 | 20000-30000 |
| *RI,% | 50-60 | 40-50 | 40-50 | 25-30 |
| *Pay back period,yr | 1.5-2.0, @150 d/y | 2-3, @100d/y | 2-2.5, @100 d/y | 3-4@ 150 d/y |
| Stage of exploitation | Commercial | Commercial | Commercial | Ready for commercialization |
| Source of availability | CIAE Bhopal | CPCRI Kasargod | CPCRI Kasargod | CIFT,Cochin |

and practices using locally available materials. Techniques have been developed to control insect infestation in stored food grains using non- toxic material such as biogas. CIAE has developed an infestation detector . There are about 5000 cold stores but mostly used for patoto. Modified Atmosphere Packaging ( MAP) and controlled Atmosphe Storage have good prospects for perishables. Cold chain stores are coming up for frozen foods, dairy products, meat and fish . Evaporative cooled lowcost storage allow safe storage of fruits & vegetables for 2-4 times the shelf life under ambient conditions.

### 2.4 Processing of Field Crops

### 2.4.1 Paddy Processing :

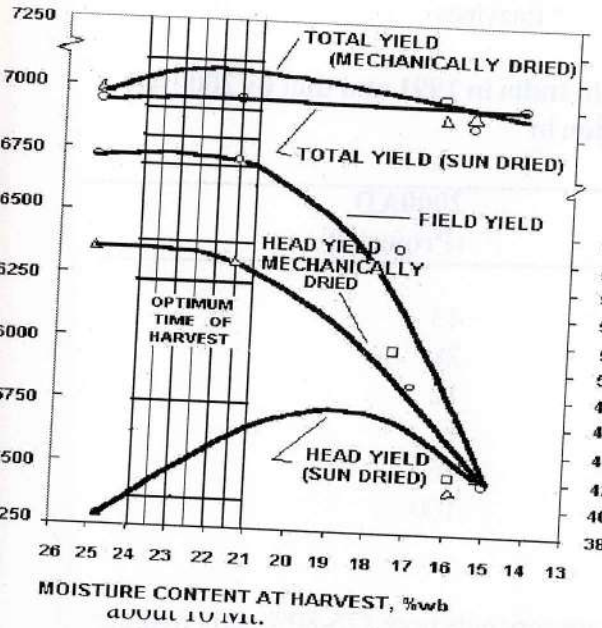
Cleaned paddy on average yields 72 % rice ,22% husk , and 6% bran. Paddy is milled into raw and parboiled rice, and flaked rice. Puffed rice is als produced as snack food. Milling is done in hullers, shellers and modern rice mills ( Table -8).Traditional hand pounding or foot pounding ( Dhenki) have become non-competitive. Hullers seldom give above 65% total yield ( Table 9) with 20-30% broken, incase of parboiled it is below 68% with 15-20% brokens . Modern rice mills (2-4t/h) and mini modern rice mill (150 550 kg/h) give best result. Field curing has profound effect on total rice yield, excessive curing tends to increase brokens. By improved haversting, parboiling, drying and milling technologies total out turn of rice can be increased by 10% ( Fig-4) Better quality parboiled rice is obtained by hot soaking steaming in well designed parboiled tank and mechancial drying , free of any odour. It also salavages damaged paddy improperly cured. Nutritionally parboiled rice is superior to raw milled

**Table -8 Break up of different system of rice milling in India (1989-90)**

| Type of Mill | Number of Mills | Per cent of total mills |
|---|---|---|
| Hullers | 76,500 | 61.2 |
| Shellers | 4,500 | 3.6 |
| Huller-cum-sheller | 15,000 | 12.0 |
| Modern/Modernised mills | 29,000 | 23.00 |
| Total Units | 1,25,000 | 100.0 |

**Table : 9 Average out- turn of raw and parboiled rice in various milling units**

| Milling units | Out - turn of rice, % | | | | | |
|---|---|---|---|---|---|---|
| | Raw | | | Parboiled | | |
| | Total | Head | Broken | Total | Head | Broken |
| Huller | 65 | 50 | 23 | 68 | 61 | 10 |
| Sheller | 68 | 60 | 12 | 70 | 65 | 7 |
| Modern | 71 | 65 | 8 | 72 | 68 | 5 |




n field yield and head rice yield (IR-8)

% endosperm, 12% bran, and 3% germ.
re are about 2,66,00 wheat milling units
425 roller mills with installed capacity of
about 10 Mt.

### 2.4.3 Maize Processing :

It is very versatile grain having food, feed, and industrial raw material value.Table10 \gives major products that are obtained from maize . In India in hills and triabal areas it is staple food . It is one of the major constituents of poultry and pig ( simple stomach animal) feed concentrate. It is also used as raw material for industrial starches and pharmaceuticals .Recent introduction of quality protein maize (QPM) opens greater opportunity for maize as food. India as at Table 11, it would be seen that over 70% it is used as feed and food. Corn flakes are very propular breakfast cereal, popped corn a very popular snackfood to even urban elite. For many boiled/roasted corn cabs become staple food for a couple of months when foodgrains are in short supply.

**Table 10: Miaze products obtained by different milling methods and subse quent processing**

| Dry-milling products | Wet-milling products | Fermented products | Other products |
|---|---|---|---|
| * Flakes | * Dextrins | * Anitibiotics | * Oil |
| * Flours | * Straches | * Beverages | * Snacks |
| * Feeds | * Syrups | * Chemicals | * Cobs |
| * Grits | * Meal | * Enzymes | |

**Table -11 Consumption pattern of mazie in India in 1991 and that by 2000 AD % of total production in**

| Consumption Pattern | 1991 | 2000AD (Projected) |
|---|---|---|
| Feed | 50 | 43 |
| Food | 38 | 28 |
| Starch | 11 | 12 |
| Seed | 1 | 1 |
| Surplus | 0 | 16 |
| Total | 100 | 100 |

### 2.4.4 Sorghum and Minor Millets :

Production of coarse cereals which are very nutritions (75-80% carbohydrates, 10-12% ,protein.3-5% oil and minerals and vitamins) have stangnated between3033 Mt. Table 12 indicates level of productin of these cereals during 1990 - 2000. When harvested they are at 15-20% moisture (Wb), however for safe storage 12-14% (wb) is needed ( Table -13) . Traditionally these are milled into flour after washing, drying, cleaning and hand picking of stones. Excessive fibre causes anti-nutritional effect, to overcome it partial pearling and subsequent grinding are recommended . Sorghum and pearl millet bran contain waxes, pigments, tannins and anthocyannis which adversely after taste and palatability . Pearling provides solution to the problems. Pearlers have been developed. Researches have been done producing diversified products from these grains.

**Table 12 Production of major coarse cereals in India during 1999-2000**

| Coarse cereal | Production, (Mt) | % of total production |
|---|---|---|
| Maize | 10.78 | 36.7 |
| Sorghum | 8.7 | 29.6 |
| Pearl Millet | 5.58 | 19.0 |
| Ragi | 2.4 | 8.3 |
| Barley | 1.1 | 3.7 |
| Small Millets | 0.8 | 2.7 |
| **Total** | **29.36** | **100** |

**Table 13 : Safe storage moisture content of oilseed for one year**

| Oilseeds | Safe, storage moisture content, % Wb |
|---|---|
| Groundnut ( pod), Rapeseed, Sunflower | 7-9 |
| Cereals | 10-12 |
| Pulses | 8-10 |
| Soybean | 8-10 |
| Sesame, Niger, Linseed, Castor | 6-8 |
| Groundnut ( kernel) | 4-6 |
| Safflower | 4-6 |

**2.4.5 Pulse Processing :**

Pulses are major source of proteins to vegetarian masses of the country. Pulses are milled in Dal in commercial Dal mills which number about 10,000. Pulses consumed as Dal have about 20-24% protein with Dal yield potential of 83-85 . However, existing commercial Dal mills have a Dal recovery 65-70% where as modern Dal mills yield about 70-75% . Traditionally Dal milling was done at home using a light weight stone grinder after pretreatment of moistening and drying or roasting. However, it does not fully decuticle the Dal which is nutritionally not undersirable but consumer preference has emerged for fully dehusked Dal.Fig 5 depicts typical steps involved in milling of pigeonpea. Table 14 gives potential Dal yield from different grain legumes used for Dal making. A number of Mini DalMills have developed to promote on -farm Dal milling namely CIAE, PKV, GBPUAT, TNAU, IIPR and CFTRI Mini Dal Mills (Table 15)

**Table 14 : Husk content and the maximum possible dal yield from some of the selected pulses.**

| Pulse (grain legume) | Husk content, % | Gota yield, % | Dal yield, % | Germ yield % |
|---|---|---|---|---|
| Bengalgram | 12 | 88 | 84 | 4 |
| Pigeonpea | 13 | 87 | 83 | 4 |
| Greengram | 11 | 89 | 84 | 5 |
| Balckgram | 13 | 87 | 83 | 4 |
| Cowpea | 12 | 88 | 83 | 5 |
| Kindney Beans | 11 | 89 | 84 | 5 |
| Horsegram | 12 | 88 | 83 | 5 |
| Soybean | 11 | 89 | 84 | 5 |
| Average | 12 | 88 | 84 | 4 |

### 2.4.6 : Oilseed processing :

Technology mission on Oilseeds brought Yellow revolution in india . Oilseed production increased several folds, 5.2 mt in 1950-51 to 24.5 mt in 2000-01. About 85% of the total oilseed is crushed for oil extraction, 8% About 85% of total oil seed is crushed for oil extraction, 8% used as food and 7% as seed . Oilseeds have about 40% oil and 20% protein . Extraction is 3- tiered, ghains that leave 10-15 % oil with the cake, expellers that leave 6-8% oil with cake and solvent extraction unit that extract most of it leaving less than 1% oil with the meal. With the increase in oilseed production and demand of the vegetable oils processing infrastructe has grown. There are about 2.5 lakh ghanis, 60,000 expellers,700 solvent extracrion plants, 200 oil refining units and 100 hydrogenation plants. Per capita oil availablity is 8 kg / year, however, it is inad equate as a result about 2Kg/ capita/yr vegetable oil is being imported making it one of the largest bills of the country. Considerable amount of R&D efforts have gone in improving oil extraction equipmennt and process. Extrusion -expelling of soybean allows 75% of oil extraction yields ediable grade cake. batch solvent- available in the market packed and branded. Attention has been drawn towards utilization of protein rich oilseed cakes and meals. Oilseeds of tree origin and minor oilseeds are alsobeing exploited like neem, Mahua, Karanj, Sal etc.

**Fig. 5 : Process flow chart and mass balance for making Pigeonpea dal (Imporved process)**

| Process step | | Output |
|---|---|---|
| **PIGEONPEA (100 KG)** | | |
| ↓ Cleaning (99 kg) | → | Impurties (1kg) |
| ↓ Milling -1 (94 kg) | → | By products (5 kg) |
| ↓ Cleaning & Grading (86 kg) | → | By products (8kg) |
| ↓ Water Soaking (20 min) | → | Loss (1kg) |
| ↓ Sun drying (12h) | → | Moisture (10% wb) |
| ↓ Milling-2 (79kg) | → | By Products (6kg) |
| ↓ Cleaning & Grading | → | Brokens (6 kg) |
| ↓ DAL (73kg) | | |

### 2.4.7 Soybean processing and Utilisation :

Soybean are new introduction in the country starting 1972 and now there are over 6 MHa under soybean 2-2.5 t/ha . Soybean have 40% protein with very healthy amino acid profile and about 20% oil. It was introduced in the counrty to combat protein

## Table 15: Dal Milling Equipment Developed in NARS

| Particulars | Dal Mill-cum-Wet Grinder | Pantnagar Dal Mill | Low cost Multipurpose Grain Mill | CIAE Dal Mill | PKV Dal Mill |
|---|---|---|---|---|---|
| Developed at Coimbatore | TNAU Pantnagar | GBPUAT Bhopal | CIAE Bhopal | CIAE | PDKV, Akola |
| **Specifications:** | | | | | |
| *Type | Power operated abrasive type portable has two seperate milling and wet grinding settings | Throughput Vertical type, decuticling spliting and burr grinder cleaning operated | Emery-stone roller through power | Emery carbo rundum stationery put type rotating | discsone and other |
| *Dimension | 765x550x790 | 6000x4000x3000 | 700x500x700 | 770x630x1020 | 1500x1200x1800 |
| * Weight (kg) | -- | -- | 69 | 90 | 185 |
| **Test Results:** | | | | | |
| *Suitability | Dal making Pigeon pea dry grinding of pulses and cereals, wet | Atta,desan, | All legumes dal, dalia, coriander and turmeric powder | All legumes | |
| *Capacity | 61 of wet rice/h | 4Q/h | 15kg/h Ata, 100 kg/h 50-70 kg/h dal 10-11 kg/h besan & coriander power | 100-150 kg/h | |
| *Milling effeciency % | - | - | - | 88-90 | 87-95 |
| *Labour | 1 | 2 | 1 | 2 | 1-3 |
| *Power | 0.5 hp motor | 5 hp motor | 1 hp motor | 2.5 hp motor | 2hp motor-Mill 1hp motor Cleaner/polisher |
| **Economics:** | | | | | |
| * Capital cost,Rs. | 10000 | 50000 | 8000 | 12000 | 50000 |
| *Unit cost of operation, Rs/q | 100 wet grinding | 50-60 | 10-30 | 40-50 | 58-64 (trading) 18-30 (custom) |
| *Working capital,Rs. | 10000-20000 | 1.5-2.0 lac | 2000-3000 | 20000-30000 | 2.65 lacs |
| *RI% | 20-25 | 30-40 | 30-40 | 30-40 | 37-84 |
| *Pay back Period, y | 4-5,@200d/yr | 2.5-3.0, @200 d/yr | 2.5-3.0, @200 d/yr | 2.5-3.0, @150 d/yr | 0.3-0.9, @240 d/yr |
| **Stage of exploitation** | Yet to be commercialized | Yet to be commercialized | Commercialized | Commercialized | Commercial |
| **Source of availability** | College of Agril Engg., TNAU Coimbatore | College of Tech. GBPUAT, Pantnagar | CIAE, Bhopal | CIAE, Bhopal | 1. PDKV, Akola 2. Manufacturer |

and fat malnutrition. However, it has turned out to be oilseed crop in the country. ICAR has taken lead in this direction. Soybean are free from cholesterol and simple carbohydrates making it a diet food for the CVD and diabetic health condition people. It also contains valuable phytochemicals and antioxidants known to provide protection against cancer. Soybean fortification known to provide protectin against functionally of foods and feeds . However, as of now about 85% of the total soybean produced is processed for oil extraction using solvent extraction units and the resultant protein rich meal is exported for use domestic feed, with depressed global market price it is finding place in domestic feed industry too. About 10% is retained as seed. Only about 5% of soybean go for direct food uses. Soybean Processing and Utlisation (SPU) center at CIAE, Bhopal has done great human service through R&D and human resource training in promoting direct food use of soybean. Table 16 gives products and equipment developed at SPU . SPU has also taken initiative to have BIS standards on some of the products.

Presently there are 265 industrial units, trading houses and goverment agencies involved with soybean as grouped in table 17 . The installed 154 soybean oil processing units have installed capacity of about 15 Mt., excessive capacity created resulting in low capacity utlization. Food uses of soymeal is hampered due to denaturertion of protein during solvent extraction excessive microbial load and residual hexane. SPU has deeloped a package of practice for solvent extracrion units to obtain edible grade soybean based on HACCP . It included both quality control and quality assurance.

In future it is aimed to promote soyfoods developed through enterpreneurship promotion, fortification of wheat and chickpea flours using edible diet and speciality foods; production of soy concentrates, isolates and hydrolysates for use in food industry; and export of value added soybean for food, feed and industrial uses.

### 2.4.8 Snack Foods :

India has tradition of snackfoods. Traditional snackfoods are puffed, flaked, and fried cereals, legumes, nuts and extruded/formed products like 'sew', 'muraku', potato and banana chips, sago and potato formed products, wide variety of sweat meals made out of Khoa, Chhena, milk, curd, all kinds of halwas usually made at home level or in small scale enterprises. Through standardisation quality control and improved packaging taste and fancy of the sophisticated consumers can also be met. In the last few years instant mixes of idli, vada, Gulab jamun, Jalebi have come in the market. Instant noodles, pasta, fruit juice, concentrates, and soft drink concentrates/powder are there beside bottled beverages. There are about 54,000 bakeries in the country that produce ready to eat baked products including buns, cookies and rusks which even poorer sections of the society use.

**Table 16: List of soyproducts and equipment developed at CIAE, Bhopal**

| (A) Soyproducts and Technology ( 13) | |
|---|---|
| * Soydhal | * Soymilk |
| * Soyflakes | * Soypaneer |
| * Soyflour | * Soy- yogut |
| * Soyfortified biscuits | * Soy-icecream |
| * Soyfortified bread | * Tempeh |
| * Soyfortified muffins | * Soy-sattu |
| *Soyfortified bun | |

| (B) Soybean Processing Equipment (19) | |
|---|---|
| * Grader | * Plate type wet grinder |
| * Manual | * Modified oil expeller |
| * Power operated dehuller | * Low -cost steam generator |
| * Blancher | * Soybean cake grinder |
| * Natural convection tray dryer | * Dough mixer |
| * Multipurpose LSU type dryer | * Loaf volumeter |
| * Three -roller flaking machine | * Lever- type paneer pressing device |
| * Two- stage roller mill for soyflake | * Screw - type panner pressing device |
| * LOw -cost single screw forming extruder | * Cottage level soypaneer plant |

| (C) Limited Scale pilot Production Facilities for |
|---|
| * Full fat soyflour |
| * Partially defatted soyflour |
| * Soymilk |
| * Soypaneer |
| * Soyfortified bakery products |

**Table 17: Industrial Units and Agencies Associated with Soybean Industry**

| | |
|---|---|
| Oil extraction plants | 154 |
| Food manufacturing units | 60 |
| Equipment manufacturers | 30 |
| Trading houses | 15 |
| Government and other agencies | 6 |
| Total | 265 |

### 2.4.9 Rural Agro-Processing Models :

Under AICRP Post-Harvest Technology of ICAR, CIAE, PAU, UAS-Bangalore, TNAU, GBPUAT and CIPHET have developed model Agro-Processing Centres (Table 18) for milling and packaging of products from cereals, pulses, and oilseeds involving a capital cost of about 2.0-2.5 lakh(excluding building) and 0.5-1.0 lakh of working capital giving employment to 4-5 people have about 40-50% return on investment (RI) with a pay back period of 2-2.5 yr@250d/year. Rural Agro Processing Models for the different regions need to be developed and popularized.

### 2.4.10 Trends in Food Grain Processing & Utilization :

Table 19 depicts the trend in food grain processing and utilization.

### 2.4.11 Crop Residue and By-Product Utilisation:

On-farm crop and live stock residues are utilized as feed, fuel and structural matrial. Processes and equipment have been developed to densify crop residue through baling, densified feed blocks and syrolsed briquetted fuel. Rice husk pigeon pea stalks, cobhearts, groundnut shells etc. have been successfully used to get producer gas for shaft power and process heat. Process and equipment are available for extraction of valuable chemicals from crop residues. Timber substitutes have been developed and commercialized from woody biomass such as jute and kenaf sticks, cotton stalks. Composites are being dveloped from fibres and woody biomass. Cotton willow dust, and jute cutting have been successfully used for biogas production. More organized efforts are needed to turn wastes into wealth.

## 2.5 Fruit and Vegetable PHT

India is second largest producer of fruits and vegetables (F&V) next only to China. F&V are essential components of food and nutritional security. F&V are alsomajor element of diversification in agriculture for additional income and employment. As a result, production, processing, and marketing of horticulture in general and F&V in particular are priority sector. For 4% growth rate in agriculture sector 6-8% growth in horticulture is considered an imperative. In the absence of awareness, skills and proper PH-infrastructure post-harvest losses in F&V are excessive 20-40%. Not only that every bumper harvest is faced with slump in the market price creating disincentives to the growers. F&V are consumed mostly fresh table grade as a result only 2% of F&V are processed in India as compared to 70% in Malaysia and over 80% in the developed countries (Fig. 6). ICAR attaches great importance to horticulture and has created Division of Horiculture which has 10 Institutes, 10 National Research Centres and 15 AICRPs devoted to horticultural crops and commodities, their production and post-harvest management. Division of Engineering of ICAR associates with Division of Horticulture addressing to the aspects relating mechanization of the horticultural crops, design and development of processes and equipment for efficient handling, packaging, storage, transport, processing and value addition.

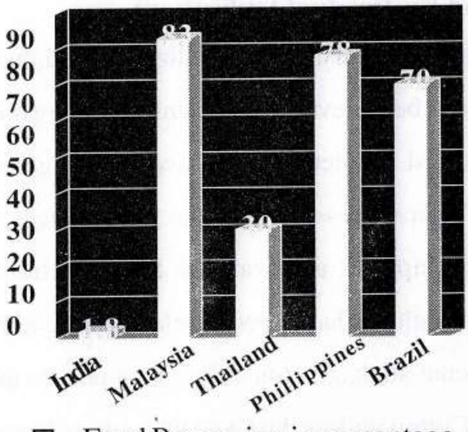



**Fig 6. Wold scenario of processing**

## Table 18 : Small Scale Pilot Plants

| Particulars | Soymilk & Tofu Plant | Moden Agro processing Centre | TNAU Tomato seed Extractor | Chillies Seed Extractor |
|---|---|---|---|---|
| Developed | CIAE, Bhopal | CIAE,PAU,UAS Bangalore,TNAU Coimbatore, GBPUAT and CIPHET | TNAU, Coimbatore | PDKV, Akola |
| **Specifications:** | | | | |
| *Type | Batch;cooker,grinder of soaked beans under 'oxygenfree' condition | Multiproduct, agri- produce processing & packaging | Power operated continuous | Power operated continuous |
| *Dimension,mm | 5000x3000x2000 | 10mx5m covered space and equal open space | 1020x615x1050 | 1090x500x910 |
| **Test Results :** | | | | |
| * Capacity | 200 l milk or 50 kg toffu per 8 hr | 300-500 kg/h<br>100-150kg/h/ata<br>200-300 kg/h rice<br>40-50kh/h dal<br>40-50 kg/h oilseed | 60 kg (fruits)/h | 4q/8h (dried chilli) |
| *Labour | 2 | 4-5 | 1 | 1 |
| * Power | 1 hp motor | 7.5 kw motor or 15 hp engine | 2 hp motor | 1hp motor |
| **Economics :** | | | | |
| * Capital cost | 2.5 lakh | 2.0-2.5 lakh (excluding building) | 15000 | 35000 |
| *Unit Cost (Rs.) | 5-7 per kg of soy | 3-5Rs/q cleaning/h<br>30-40 Rs/q flour<br>25-30 Rs/q rice<br>80-90 Rs/q oil | 30 Rs/q | 30 Rs/q chillies |
| *Working Capital (Rs) | 0.50-0.75 lakh | 0.5-1.0 lakh | 15000-30000 | 50000-60000 |
| *RI,% | 40-50 | 40-50 | 50-60 | 40-50 |
| *Pay back, y | 2-2.5@250d/yr | 2-2.5@250d/yr | 1.5-2.0@30 d/yr | 2-2.5@30-35 d/yr |
| **Stage of exploitation** | Commercial | Release for Yet to be populatization | commercialized | Commercial |
| **Source of availability** | 1) M/S. SSP Ltd, 13 Mathura road, Faridabad - 121003<br>2) M/S. Monica processing Plants, 10-A, Sneh Nagar Indore-452001<br>3) M/s. Raylans Metal Works, P.O. Box 17426 JB Nagar Andheri (E) Mumbai-400059<br>4) M/S. Sanjay K. Gupta, 5, Gandhi Nagar, Pathakheda, Betul-460449 | 1. CIAE, Bhopal<br>2. CIPHET, Ludhiana and other mentioned organizations | College of Agric. Engg. TNAU Coimbatore | College of Agric. Engineering PDKV, Akola |

Table 19 : Trends in food and agro-prorocessing in India

| S.No. | Crop / Commodity | Trends in processing and utilisaton |
|---|---|---|
| 1. | Rice | * Fully automatic modern rice mills, color, sorting, hyrdo-polish<br>* Mini modern grain mills replacing hullers<br>* Partially cooked, quick cooking rice-DFRL, CFTRL<br>* Improved praboiling of rice-IIT,CFTRI,PPRC designs<br>* Breakfast cereals and value added products<br>* Idli/Dosa mixes<br>* Branded packed products<br>* Rice bran oil-ediple and non-edible uses |
| 2. | Wheat | * Fully aotomatic roller mill (700)<br>* Fortified wheat-flour, packed and branded<br>* Pasta & Macron, roasted samolina and Dalia<br>* Baked products, full bran wheat bread<br>* Automatic chapatl making machine<br>* Mini-grain mills -CFTRI, CIAE |
| 3. | Maize | * Quality corn flakes & snack foods, packed and brand<br>* Sweet abd baby corn, QPM<br>* Automatic maize processing plants, starch, oil<br>* Livestock feed -loose and pelleted |
| 4. | Coarse cereals | * Value added products |
| 5. | Pulses | * Improved Modern Dal Mill<br>* Mini Dal Mills, CIAE, PKV,IIPR, GBPUAT, CFTRI designs<br>* Legume based snack foods<br>* Consumer packaging and branding |
| 6. | Soybean | * Soy foods, ready to ear snack foods<br>* Full, partially and defatted soy flour<br>* Vegetable grade green soybeans |

### 2.5.1 Excessive Post-Harvest Losses in F&V :

Post-Harvest losses in F&V have been estimated ranging between 20-40% which in economic terms comes to stagging figure of Rs 17,723 Crores (Table2). The major reasons for these losses are:

1. Untimely harvest and mechanical injuries during the process.
2. Growth of micro-organisms (yeasts, molds & bacteria).
3. Life processes of these biologically active materials/ post-harvest physi ological factors.

4. Enzymatic activities, browning, discolouration.
5. Physical changes like desiccation, shriveling, loss of turgidity.
6. Chemical changes such as oxidation.
7. Spoilage and mechanical during harvest handling, packaging transport and storage.

### 2.5.2 Temperature Management in F&V :

Chilling of perishable produce immediately after harvest and keeping them cool during transport, storage and retailing pays dividends in many ways. It minimizes losses, the produce reaches the consumer in far better condition than without cooling for which they are willing to pay more, properly cooled foods retain their shape,colour, taste , flavour, minerals, other oxidisable chemicals and nutrients. Refrigerated transport enables taking perishables to distant remunerative markets without spoilage. Such a capacity also enables the growers and the traders to negotiate with orchestrated market glut or achieve value addition just through off season sales. The need for cooling is far more general than is popularly believed. F&V, milk, meat, fish, eggs, dairy products, mushroom, yeast etc. are recognized perishable foods which must be refrigerated during transport and storage. This is so because natural resistance of these products to pathogens is lost after harvest.

### 2.5.3 F&V Storage :

All F&V continue to respire generating $CO_2$, $H_2O$ loosing weight, turgidity, appeal and marketing qualities due to desiccation. By cooling close to freezing respiration is minimized, if not totally arrested. However, the enzymic action continue which slowly destroys the tissues internally, what is called autolysis. Autolysis stops at much lower temperature (-40°C). At temperature - 10°C molds and yeasts seldom multiply. Bacteria may survive but multiply very slowly and are not cause of concern. However, oxidative enzymic activities may change flavour, cause browing in processed product, destroy vitamins and other nutritional values. For on-farm storage and bulking of harvests of F&V evaporative cooled storages have been developed and received well by the farmers evoprative could storage have developed and received well by farmers.

### 2.5.4 Cold storages and Cool Chain :

India has about 5000 cold stores. These are largely used for storing potatoes.Other commodities cold stored are apples, grapes, citrus, milk, fish, meat, chillies, jaggery, cabbage, carrots and frozen products. Capacity of a typical cold store is about 5000 6000 t (60,000 - 80,000 bass) of materials with plant and machinery costing Rs 25 - 50 lakh. Land, building and its insulation may cost about 200 lakh, requiring electrical power connection of 340 KW and 7-8 staff to rum it. These cold stores operate on custom service basis charging @Rs 50 /-70 per bag for three months.As compared to cold storage that require higher investment, a small cold store or retail outlet for perishables may need an investment of about Rs 1,00,000 on equipment and masonary, 15-20 m$^2$

space, and 3-4 people to run it.

### 2.5.5 F&V Processing :

Processing of table grade F&V involves washing, cleaning, grading, packaging for efficient handling, transport and marketing. However bulk of F&V are marketed in local market without processing, not even cleaning and grading. Traditional F&V processing includes sundrying, pickling and preservation in thick syrups - Morabbas. However, now jam, jelly, squash, ketchup etc. have come up even at domestic and cottage industrial level. Some popular fruit products are as under:

| | |
|---|---|
| Mango: | Mango leather, pickles, squash, osmodehydrated slices, mango juice, powder, etc. |
| Guava : | Jam, jelly, squash |
| Grapes : | Raisins, wines |
| Banana: | Chips, powder, puree |
| Apple : | Juice, preserves |
| Orange: | Squash, peel powder |
| Ber : | Ber preserves, jam, dried Ber, pulp powder |
| Papaya : | Papain, pickles, candies |
| Pomegranates: | Anardana, syrup, squash |
| Amla : | Morabba, pickle, dried, chevanprash |
| Lime : | Squash, pickle, citric acid powder |

Some of the traditional products like sauces, chutneys, pickles, etc. have proven their export value. Vegetables are being processed into minimal dehydrated processed frozen, pickled, sauce etc. By improving hygiene, packaging, transport, steady and reliable supply export markets can be expanded.

### 2.5.6 New F&V Products and Processes :

CFTRI has released a number of technologies for F&V processing such as fruit toffee, fruit bar, tutty fruity, improved Morabbas, osmo - dehydrated fruits, Anardana, fruit juice, syrups & beverages etc.Radiation preservation has come into use in India. It is already been standardized and cleared for potato, onions, spices etc. Controlled and modified atmosopher storages, UHTP, ostomotic dehydration and membrane filtration have been studied and standardized for some applications. However, more efforts are needed.

### 2.5.7 New Equipment Developed for PH - Management of F&V :

A large number of PH equipment and practices have been developed in the last one decade (Table 2-4, 6) which can be helpful in reducing PH-losses, improving, handling storage and processing of F&V such as pre-harvest management, zero energy cool chamber /evaporative cooled storage, onion curing and storing structure, solar passive and active tray dryers, green chickpea dehulling, Pea pealing and punching machine handling, storage and processing of F&V, such as pre-harvest-management, zero energy cool chamber/ evaporative cooled storage, onion curing and storage structure, solar passive and active tray dryers, green chickpea dehulling, pea pealing and punching machine, semi-mechanised mango pickling plants, bulk cashew dehuller, seed extraction for tomato, brinjal, chilies, garlic bulb breaker, fruit pluckers, kinnow cutters, kinnow grader, fruit and vegetable grader, banana and orange packaging lone. Process and equipment have been developed for snow-ball, osmo-dehydrated tender coconut slices, dehuskers for coconut and arecanut dehuskers, cardamom and cocoabean dryers, tamarind dehusker and deseeder, cassava chipper, cassava dryer, cassava starch extraction unit.

## 2.6 Commercial Crop Processing :

### 2.6.1 Sugarcane :

India produces about 300 Mt of sugarcane manually harvested, detopped and detrashed of which 53% processed into white sugar, 36% into jaggery and khandsari, 3% for chewing and cane juice, and 8% as seedcane. Major jaggery and Khandsari producing states are UP (49.8%), AP, TN, Haryana and Gujarat where as major white sugar producers are MS (97% of the cane produced), Gujarat (66%), TN (57.8%), AP (57.7%), Haryana (5.9%) and UP (36.7%). India has about 400 sugarmills, 800 khandsari units and 7.5 lakh jaggery making units. There are about 8 lakh animal and power operated cane crushers extract about 60-65% juice as against 75% extraction in sugarmills. India contributes about 15% to the world sugar production. Sugar and jaggery and khandsari consumption in India is about and 10 and 15 Kg per capita per year. Jaggery is not just sweetener but rich source of minerals and vitamins. Jaggery is a traditional cottage industry that has withstood competition from organised sugar industry. AICRP Jaggery and Khandsari of ICAR has standardised processes for quality solid, liquid (Fig. 7) and powder jaggery. It has also developed equipment for regular shape solid jaggery, packaging and storage techniques. Liquid jaggery has been commercialised. Organic clarificants have been developed to avoid use of chemicals. Jaggery chocolate has been developed, response is favourable.

### 2.6.2 Jute and Kenaf :

Jute has distinction ushering India into industrialisation. World Production of jute, kenaf and allied fibres (JAF) is at about 3.37 Mt per annum, developed countries about 3.36 Mt with Indian contribution of 1.84 Mt. India is largest producer and Jute is a wonderful plant, for each tonne fibre it gives 2-3 t woody biomas consumer of JAF. Jute is an eco-friendly natural fibre, which find varied users. Traditionally jute has been used for packaging agricultural and forest produce, hessian carpet backing. Polyproplylene has seriously eroded the traditional market. As a result R&D efforts were made at NIRJAFT to diversify uses of Jute and Kharif fibres and blends for furnishing, blanket, drapery, aparel, geotextile, light weight bags. Jute sticks yield excelled particle boards and other timber substitute. The technology has been commercialised. Jute sticks and whole jute and kharif plants can be used for paper and pulp production. Efforts are on to produce jute composites for industrial uses. NIRJAFT has developed standards and equipment for jute grading, standards and specifications of Jute textiles, dyeing of jute fibre, yarn and fabrics. Mini spinning system developed at NIRJAFT enables production of jute utility goods in decentralized sector.

Jute mills are located in urban areas using jute bales produced in production catchment. NIRJAFT has developed Mini Jute carding and spinning Mill which allow decentralised production of utility items from jute and kharif fibre. However, it has yet to become popular.

Ramie is a fabric grade bast fibre. However, its cultivation and fibre extractio and degumming is not yet popular. Industry has started putting demand on ramie fibre. Efforts are on to provide R&D support to this demand both from production and post-harvest angle.

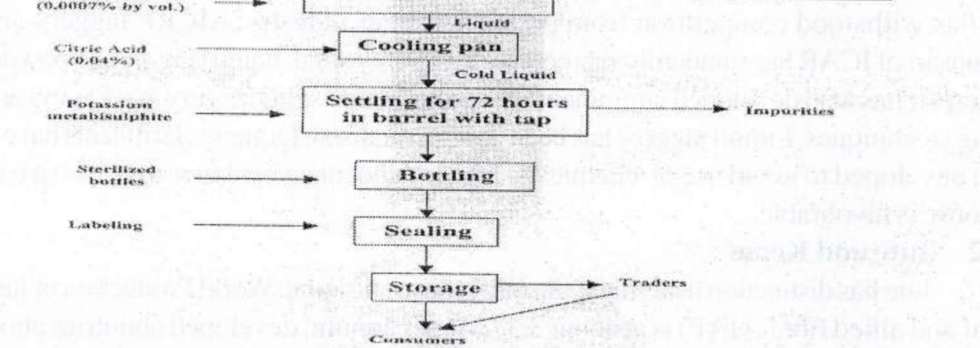



**Fig. 7 Process Flow Chart for Manufacturing Liquid Jaggery**

### 2.6.3 Cotton and Post-Harvest Technology:

Antiquity of cotton cultivation and use can be traced to 3000 BC. It became acommodity of international trade when Alexamder invaded India in 320 BC. Dacca Muslins were exported by East India Company, some of them were finer than 300 counts. However Industrial Revolution in Europe in the 18th century changed the scenario specially with raw cotton becoming export commodity instead of Muslin with the invention of power operated spinning and weaving machines. In 1947 India produced 3.9 million bales of cotton 40% coming from past now part of Pakistan. Mostly *G arboreum* and *G herbaceum* were grown. Now the scenario has changed hybrids accounting for 43% and *G.hirsutum* 29%, arboreum and herbaceum at 17% and 11% respectively (Table 20).

**Table 20: Species of Cotton cultivation in India**

| Type | Cultivation Area (%) 1947-48 | 1999-00 |
|---|---|---|
| *G.arboreum* | 65 | 17 |
| *G.herbaceum* | 32 | 11 |
| *G.hirsutum* | 3 | 29 |
| *G.barbadense* | Nil | * |
| Hybrid | Nil | 43 |

* *Negligible in percentage*

Cotton is important element of Indian economy in that it provides livelihood to 60M people and contributes to India's export earning. India has largest area under cotton in the world 9.10 Mha out of total 33.89 Mha. However, being largely rainfed average productivity is low 308 kg/ha but it is much higher than that in 1947 (88 kg/ha). There are about 27 cotton varieties cultivated, nine of them accounting for 75.8% of the total. CIRCOT provides PHT support to Cotton Breeders in the development of cotton varieties and projecting needs of the industry to them.

Indian cotton is 100% handpicked yet Indian cotton bales carry 6-8% trash lowering the market price primarily because pre-cleaning is not practiced. CIRCOT has developed an indigenous which has been commercialised and forms part of Ginneries modernisation programme under TMC - MM IV. Double Roller Lines have been improved and Mini Gins developed. There is also demand for mechanised cotton picking for which R&D efforts are on. In such a situation to remove trash picked up during mechanical picking saw ginning will be needed. Studies and human resourcedevelopment in ginning and pressing are being undertaken.

All of cotton plants with the exception of cotton and cotton seed are classified as wastes. Cotton seeds are valued for oil and livestock feed. R&D at CIRCOT have yield quality particle boards, craftpaper and CFB packaging boxes from cotton stalks, microcrystaline cellulose (MCC). Cotton hulls yield furfural, found to be good substrate for mushroom production.

## 2.7 Live-Stock Products

### 2.7.1 Milk:

Cattle and buffaloes are the main constituents of livestock population contributing to milk production. India has about 14 percent of world's cattle and 55 percent of world's buffalo population. There are around 30 different zebu breeds in Indian sub-continent. The country has about 204 million cattle and 84 million buffaloes, out of which 70 million and 44 million are breedable cattle and buffaloes respectively. Goat, sheep and camel milk as of now has little commercial significance, though at microlevel it does have economic value and thus deserves R&D attention.

The average milk production of indigenous cattle in the country is about 500 L per lactation which is the lowest. However, the Haryana Tharparkar, Sahiwal and Red Sindhi breeds of zebu yield around 1800 L in 305 days. Most of other zebu breeds are non-descript. Average milk yield of buffaloes ranges from 1500-2500 L per lactation. Brazil has adopted Indian zebu both for milk and meat, likewise Bulgaria has adopted Murrah buffalo.

### 2.7.2 Milk Production:

India produces 78 Mt of milk annually 55% of which comes from buffaloes.Though the cattle population is 2.5 times more than buffalo but their contribution towards the milk production is less than half. India is now the largest producer of milk in the world. As a result of the White Revolution in the country milk availability has improved to 212 g/caput/day against recommended dietry need of 220 g/caput/day.

### 2.7.3 Milk Processing Infrastructure in India :

The organized dairy sector handles about 15 percent of total milk produced in India through about 575 dairy \factories in cooperative, public and private sector. Dairy factories are capital-intensive units, a technology that evoloved in cold climate. HTST pasturized milk requires to be handled through a cold chain. In the modernization of the Indian Dairy Industry, great emphasis was laid upon the supply of processed milk to the city consumers. A national milk grid has been established under the Operation Flood Programme to build a strong link between the milk surplus and deficit states and between rural producer and the urban consumer.

### 2.7.4 Milk Consumption Pattern in India :

Table 21 gives the milk consumption pattern in India:

**Table 21: Milk and milk products consumption pattern**

| | |
|---|---|
| Liquid milk | 45% |
| Ghee | 28% |
| Dahi | 7.0% |
| Khoa | 6.5% |
| Butter | 6.5% |
| Milk Powder | 2.6% |
| Channa, cheese and Paneer | 2.0% |
| Cream | 0.5% |
| Ice-cream | 0.2% |
| Others | 1.7% |

### 2.7.5 Trends in Dairy Processing:

More than 50% of the surplus milk is converted into indigenous milk products like Ghee, Khoa, Dahi, Channa, Paneer and other milk food delicacies and sweatmeals. It can be export item to countries like Iran, Iraq and other ME countries. The organised dairy plants produce over 1,65,000 tonnes of milk powder, 110,000 tonnes of ghee 40,000 tonnes of butter and 20,000 tonnes of cheese.

New technological processes such as fractionations, electro-dialysis, and memberane separations etc. have helped to treat milk as an industrial liquid whose valuable ingredients could be extracted and recombined in different ways to form new products. It is possible to make cholesterol free or low cholesterol free or low cholesterol butter or ghee. Dairy products today are tailored to suit the changing social and dietary habits.Processes have been standaridized for production of whey protein concentrates, low fat-chadar cheese, Mozerella cheese, instant mix of Makhana Kheer. Efforts are on for manufacture of fermented and non-fermented whey based fruit juiceconcentrates and value added products from goat and camel milk.

Major part of milk is being sold as fresh milk to the consumer within just a few hours after it leaves the cow. Large chunk is still being handled by unorganised sector producing Indian milk products or traditional milkproducts such as Dahi, Ghee, Khoa, Channa and Paneer. Traditional method of extending shelf life of liquid milk is by boiling and in doing so there is loss of some nutrients.

### 2.7.6 Mechanisation in Indigenous Milk Product Production:

During last two decades, efforts have been made at NDRI, NDDB and IIT, Kharagpur towards mechanised manufacture of Ghee, Khoa, Paneer, Channa, Shrikhand, Gulabjamun and Peda.

***Equipment for Khoa making*:**

Khoa is a heat desiccated or dehydrated prod uct obtained through boiling of whole milk under atmospheric conditions. For small scale khoa production, a batch type scraped surface heat exchanger (SSHE) and a conical process vat (CCPV) has been developed at NDRI to produce up to 20 kg, Khoa in one hour. For medium scale operation, a thin film scraped surface heat exchanger (TFSSHE) has been developed to produce40-50 kg Khoa per hour from raw whole milk. Similarly, for large-scale production, an inclind type scraped surface heat exchanger (ISSHE) is developed to produce 250-300 kg Khoa in one hour from pre-concentrated milk. All of these machines are patented and are being manu factured by M/s Pasteur Engineering Co., Calcutta, M/s SSP Pvt. Ltd., Faridabad and M/s IDMC, Anand respectively. A number of these units are already installed. Based upon users response these are being further refined by the fabricators.

***Equipment for Ghee-making:***

Trditionally, Ghee is made by open pan concentration in a shallow iron pan kept directly on stove/furnace. The operation is mechanised at two levels of operations. A batch system by employing the ghee Kettle/boilers and the conical process vat. It has capacity to produce up to one tonne of ghee in a shift of 8 hours. For larger capacity, a continuous scraped surface heat exchanger is designed and developed to roduce ghee @ 500 kg per hour.

***Equipment for Gulabjamun production:***

The NDDB, Anand has adopted a dough mixing and meatball-forming machine for Gulabjamun manufacture. This system has an integrated deep oil-frying unit, linked with a tray packaging to produce cylinderical shaped product in hygienic manner. The plant has capacity to produce 200 kg of Gulabjamun per hour. Unit, however, has not been multiplied for other dairies.

***Production of Channa/ Paneer:***

Although their end uses are different, the production procedures for these two products are very similar in that both are produced by acid coagulation of hot milk followed by separation of curd from whey. Paneer making involves an additional step of pressing curd into firm block prior to cooling. Recently a continuous Paneer/ Channa making system has been designed and developed at NDRI to manufacture 80 kg/h of the product. Sponsorers are being identified to adapt this unit for commercial production.

***Shrikhand making equipment***:

Shrikhand is a soft plastic product obtained by removing whey from lactic fermented milk and kneading the resulted curd (Chakka) together with sugar flavouring material etc. It is a popular product in the Western part of the country. Commercial scale production of this product has been carried out at Baroda Dairy under NDDB sponsorship.A large size quarg separator adapted for this purpose is main feature of this unit. A few other manufacturers have also employed similar units to produce large-scale Shrikhand. However, there are no manufacturers fabricating Shrikhand processing unit but they can fabricate on demand.

### 2.7.7 Prospects of Primary Processing of Milk at Producers Level:

Milk being highly perishable requires special care in production, milk handling and processing. It involves health of animals and men who handle them, feed, water, sanitary condition of shelter and processing site and equipment. The CODEX regulation have imposed hygiene levels that need to be addressed for example, use of milking machines, bulk milk coolers to collect and preserve milk almostv instantanously. Quite a good number of milking machines for cow and buffaloes are available. The break-even comes if the herd size is at least 15 animals . Similarly, portable milking machines are also available. There are different types of chilling and storage system in use. After achieving the clean milk production processing of milk into value added product could also be considered. Even in developed countries, the farmers do cater the need of other than liquid milk supply. In our conditions also some small scale processing is being done. There is scope tp produce Khoa, Paneer, Whey drinks and curd, Kulfi and Kheer etc. at producers level. The technologies required are available. Some efferts are needed to provide well-designed equipments and skills to adopt these technologies. One has to ensure quality to facilitate marketing.

## 2.8 Meat and Meat Products

Meat production in India has reached to 4.46 Mt, ranking 7th in the World, 60% of which comes from beef and buffalo (spent). Buffalo meat alone fetches Rs 1200 crores annually through export of deboned frozen meat and is likely to reach Rs 1500 crores this year. It goes mostly to Malaysia, Philippines, Kuwait, Egypt, Saudi Arabia and other ME countries. Value added products have been developed from spent buffalo meat such as sausages, nuggets,meat blocks etc. Similarly, value added meat products have been developed from spent poultry, sheep and goat meat. DFRL and CFTRI have developed technologies for spent chicken curry in retortable pouches.They are also working on instant pulav and biryani. However, processed meat products are only 2% of the total meat produced, a target of 10% level has been kept by developmental departments. Spread of Madcow disease has given spurt to Indian meat and meat products exports.

## 2.9 Egg and Egg Products

Egg is natural well packed unadulterated protein food. Hen egg may weigh 35-50 g each. Poultry both for egg and meat has been a success story in India. Egg production is around 28.56 billion (97-98) with per capita availability of 30 eggs/annum. India is exporting egg powder. Egg yolk is used to dilute semen for AI activities. Albumin flakes are used in printing currency notes.Pickled quail eggs are available as snack food.

## 2.10 Wool

Sheep, camel and Pashmina goats provide wool and mohair. Indigenous wool produced is of coarse type except for Pashmina. Breeding and intoduction of exotic breeds have been tried. However, for quality fine wool we still depend upon imports from Newzealand, Australia. Spinnability of wools and its blends have been studied. Upto 60% mohair with wool have been found easily spinnable, upto 70% Angora rabbit hair have been successfully spinned. However, for smooth spinning and even yarn a 30:70 Angora rabbit hair and Merino wool is found to be the best. Blend for shawl fabric (40:60 Angora and Merino wool), Tweed (Angora and wool) and Blazer (Mohair and wool blends) have been developed for field application.

## 2.11 Fish Post Harvest Technology

### 2.11.1 Fish Production in India:

India is the sixth largest fish producer in the world and second in inland fish production. Fishery also plays an important role in export earnings (US $ 1.1 billions). Starting with a humble productioin of 0.53 Mt in 1951 in the marine sector, the cou ntry attained an all time high figure of 2.94 Mt in 1998. This was made possible by the R&D inputs given by a large number of research institutions in the country and also development plans initiated at national level by the union government and the state governments. The notable among them was the advent of Norwegian assistance in mecha nization fishing operations through the Indo Norwegian Project. The Central Institute of Fisheries Technology (CIFT), Cochin played a vital role in the mechnization of fishing operations.

Over eighty percent wooden fishing trawlers operating in Indian waters up to 50 ft OAL are all made of CIFT design. CIFT also was responsible for the introduction of fish inspection and quality control in India. The marine production has come to a plateau in recent years stagnating around 3 million Mt. Any further increase from the sector has to come by exploiting the deep sea resources for which only some attempts were made. Vast Tuna resources of the deep-seas on the EEZ need to be harvested to bring more income to this sector and conservation of over exploited stocks is a major issue of marine fisheries. India's fish production is given in Table 22.

**Table 22: Fish Production in India (1997-98)**

| STATE | MARINE | INLAND | TOTAL |
|---|---|---|---|
| Andhra Pradesh | 0.15 | 0.23 | 0.38 |
| Gujarat | 0.75 | 0.07 | 0.82 |
| Karnataka | 0.19 | 0.10 | 0.29 |
| Kerala | 0.52 | 0.06 | 0.58 |
| Maharashtra | 0.45 | 0.13 | 0.58 |
| Orissa | 0.16 | 0.15 | 0.31 |
| Tamil Nadu | 0.36 | 0.11 | 0.47 |
| West Bengal | 0.17 | 0.79 | 0.95 |
| Andaman & Nicobar Island | 0.03 | - | 0.03 |
| Pondicherry | 0.04 | 0.004 | 0.04 |
| Bihar | - | 0.21 | 0.21 |
| Punjab | - | 0.04 | 0.04 |
| Utter Pradesh | - | 0.16 | 0.16 |
| Assam | - | 0.16 | 0.16 |
| Others | 0.13 | 0.19 | 0.37 |
| **Total** | **2.95** | **2.44** | **5.39** |

***Data: Courtesy, Ministry of Agriculture, Govt. of India***

**Demand, Supply and Gap:**

With the projected increase in population, unless there is a fall in growth rate, India's additional demands for fish by 2020 AD will be around 5 million tonnes. This means, we have to double our fish production by 2020 from the present level of 5.4 Mt in 1999. With the production from Marine Capture Fisheries declining, additional demand arising will have to be met by aquaculture only.

**Indian Seafood Industry, history and present profile:**

The Indian seafood industry has a very humble beginning. It started in the early part of the century with the export of the dried fish to Sri-Lanka, Burma, Singapore,Hongkong etc.,mostly South-East Asian countries. In the 1950's the country started export of canned shrimps and fish. The fish canning industry suffered a set back in the later half of the 1970's and never regained its stature. The main reason is the high cost of metal cans used to pack fish. The tin plates used to manufacture marine caneswere imported to India. Indian canned fish became non-competetive in the international market compared to countries Thialand, Fiji, Spain, Portugal etc.The 1950's saw the emergence of India as a supplier of frozen shrimp, block frozen in different styles to Europe, Japan and America. Today the country exports value added marine products worth Rs 500 crore. Currently India exports over 55 commodities to world merkets. A number of conventional value added and non-conventional products are also now exported from India.

**3. Products developed under aegis of ICAR.**

**Marine Fisheries:**

**Major**

Frozen Shrimp

Block Frozen and IQF

Value added products

**Frozen fish:**

High value: Pomfrets, Seer, Perches, Tuna, Squid, Cuttle fish, Lobsters etc.

Low value: Sardines, Mackerels, miscellaneous.

**Miscellaneous**

Fish oil

Dried Fish

Clams, Mussels, Oysters (Frozen dried)

Sharks

Dehydrated sea cucumber

Freeze dried products

**High value by-products**

Chitin

Chitosan

Icing glass (Fish maws)

Fish Pickles:

**Value added products**

Battered and breaded products

Surimi

Extended and formed products

## 4. Management Strategies

It is easy to have a processed product but much more difficult to market it. In absence of proper marketing or linkage with a agency who can bulk buy, often an enterprise or PHT activity becomes a non-starter. One can draw inspiration from some of the successful food and agro models.Mention is made of the following:

**1. Amul Pattern:** Production by masses, processing and marketing by state of the art technologies, and qualified professionals both networked through coperative linkages.

**2. Tea industry Models:**On-farm primary processing and grading as per BIS standards, and auctioned for blending and marketing in the organised sector with established brand names.

**3. Sugar Industry:** Organised industry in production catchments with loose tie up with the growers, the Government playing a moderator.

**4. Gur and Khandsari:** On-farm cottage industry catching to ethnic need, successfully competing with organised sugar industry.

**5. Cotton Textile Industry:** Ginning and baling (primary processing) in production catchments, spinning, weaving (secondary processing) in the organised sector.

**6. Power Looms:** Decentralised efficiently managed unit at scales free from trade unionisms catering to certain range of products.

**7. Atta Chakkis:** Small low capital unit doing custom processing to the satisfaction of customers.

**8. Lijjat Papad:** A traditional product of wide use produced using unem -ployed/ underemployed human labour, organised as cooperative, marketing through available marketing networks.

**9. Mobile Door to Door:**Craftsmen, mechanics, moving on bicycle, service cart or tractor trolleys with necessary equipment for door to door service/custom milling.

## 5 Future Priorities

* Modernisation of milling and processing of food grains, oilseeds, horticultural crop, animal products and fish.
* Development of processes and pilot plants for diversified uses of commercial crops, test marketing, industrial liasion and extention.
* Genetic manipulation for long shelf life, diseases and environmetal stress resistant cultivars.
* Modelling of post production system for optimization and on-line controls.

* Environmental friendly storage pest management.
* Optimal harvesting time and techniques.
* Post harvest treatments to increase shelf life and storability (heat,UV, irridiation, CA, chemicals).
* Energy conservation and efficiency in refrigeration and air conditioning systems.
* Standardization of CA storage nand MAP for tropical fruits, ornamentals, planting material, fresh pack and lightly processed produce.
* Microprocessor controlled processing and storage.
* CA storage during transport.
* Humid forced aeration and cooling.
* Establishing impact and viberation norms to prevent bruising and mechanical damage during sorting and packaging.
* Quantitative non destructive measuring of quality and maturity.
* Environmental friendly packaging of produce and processed products.
* Study of consumer and market quality preferences in domestic and export market.
* Technological and management innovations to improve return on investment of post harvest enterprises.
* Basic research on post harvest physiology, senescence ripening, respiration, ethylene effect, chilling, fermentation, superficial browning.
* Energy audits of post production systems and energy conservation measures.
* Study and application of supercritical $CO_2$ extraction of high value oil and oleoresin extraction.
* Processing and utilization of underutilized plants, crop residues, byproducts and waste into high value products of food, feed, fuel, pesticide and pharmaceutical value.\

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# Need for increasing value added farm Products

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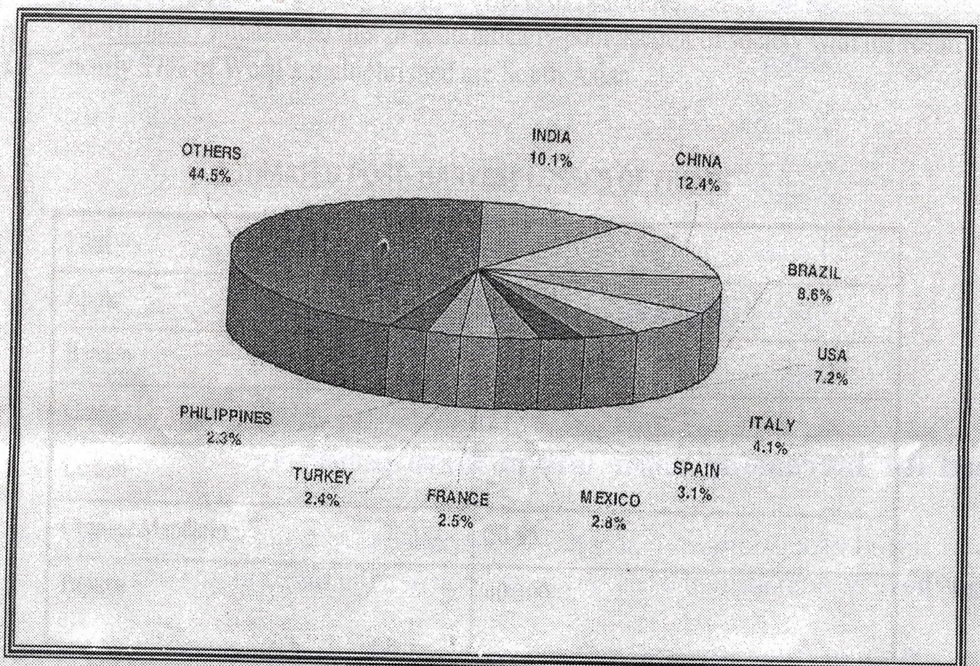
## Agricultural Status of the country

- 74 per cent population lives in the rural areas
- Small & marginal farmers hold 78 per cent of the area
- Rural nutritional scenario is paradox.

**Indian Agricultural Production**

| S.No. | Item | Production (MT) |
|---|---|---|
| 1 | Wheat | 6.840 |
| 2 | Sugarcane | 301.40 |
| 3 | Maize | 9.57 |
| 4 | Vegetables | 90.80 |
| 5 | Livestock | 396.00 |
| 6 | Milk production | 81.00 |
| 7 | Rice | 8.630 |
| 8 | Oil seeds | 18.20 |
| 9 | Fruits | 45.50 |

**World-Wide Production Share of Fruit**



**Indian Horticulture Scenario**

Horticulture sector, which includes fruits, vegetables, roots, tuber crops, mushrooms, floriculture, medicinal and aromatic plants, cashew nut and plantation crops, has established its credibility for :

- Improving prductivity of land
- Generating employment
- Improving economic conditions of the farmers and enterpreneurs
- Enhancing exports
- Providing nutritional security to the people

The focussed attention has witnessed the emergence of Horticulture as an enterprise.

- Lack of community based programme in production and marketting
- Storage facilities and adequate transport infrastructure are lacking
- Lack of agro-based processing facilities
- Lack of long term integrated programme for disaster mitigation in disaster prone area
- Lack of awareness regarding harmful effects of pesticides
- Nutritionally imbalanced diet in economically poor section of society with the result nearly 37% of World's malnourished are South Asian

## Estimated Post-harvest losses of fruits

| Fruit | % Loss |
|---|---|
| Apple | 14 |
| Banana | 20-80 |
| Grape | 27 |
| Lemon | 20-85 |
| Orange/Mandarin | 20-95 |
| Papaya | 40-100 |

## Need for increasing value added farm products

- Food processing industry has been termed as a "Sun rise industry" and several efforts have been made in the last few years to give a big thrust to this sector.

- With the liberalization of the economy in 1991 and globalization, it was felt that food processing industries would come up in a big way. Sadly enough, the hopes have been belied. During the post liberalization period of 1991-2000, foreign direct investment approved in food processing sector was Rs. 84 billion through 698 collaborations, of which 137 were of technical nature and 561 were of financial nature.

India is today the second largest producer of fruits and vegetable with a total annual production of 139 million tonnes. Huge losses to the extent of 30 to 40% of the produce are reported due to lack of adequate infrastructure. Even though we have more then 5000 FPO licensed units in the country, hardly 2% of the produce is utilized for processing as compared to 30, 70, 78 and 83 % in Thailand, Brazil, Philippines and Malaysia respectively.

- Availability of fruits is seasonal. During off-season they are either not available or heavily priced, thereby affecting the consumers. Even other agro-products like onions face price fluctuations of oscillating from lower end to un inaccessible peak price.

- This is a perplexing situation, and the remedy is possible only through processing of food using methods such as dehydration and cold chain and with other proven chemical and irradiation processes. This will help to preserve food articles when their availability surpasses the immediate need, so that they can be released for consumption when the season subsides.

- Since processing preserves food articles from perishing, prices can also be controlled. This will enable even the poor to have access to them. It will be a win-win situation for both the farmers as well as the consumers.

- The size of global food market is as of now is estimated to be an astounding $69.4 billion of which value added food products garner the share of $ 22.2 billion. In view of the tremendous potential of Indian food processing Industry, the Union Government has increased its allocation to the Ministry of Food processing by 33.53% to Rs 81.01 crore in the Budget.

**Economic impact of Value Addition**

- Diversification of the economy, in order to reduce present dependence on one export commodity;
- Reduce fruit and vegetable losses;
- Reduction of imports and meeting export;
- Stimulate agricultural production by obtaining marketable products.

**Economic impact of Value Addition**

- Improve farmers nutrition by allowing them to consume their own processed fruit and vegetable during the off-season;
- Government industrialization policy;
- Development of new vale-added products;
- Generate new sources of income for farmers/artisans.

**Historical Account of food Processinmg (World)**

- The art of presevation of food-meat, fish, Vegetables and fruit has been known since ancient times.
- Needham (1749) explained first time the cause of spoilage.
- Spallanzani (1765) put forward the view of microorganisms responsible for spoilage.
- During Napoleonic war the French Govt. announced a reward of 12000 Francs, for improving the processing.
- M. Nicholas Apart (1804) was first to report sucessful preservation of food in glass container.

**Historical Account of food processing (India)**

- Fruit & Vegelable processing started in 1857.
- Fruit & Vegelable canning started in 1927.
- Fruit & Vegetable soft drinks started during 1927-1942. (Squash, Juice, Cordial & Barley water).
- Jam, Jelly & Marmalade Sauce & Puree 1940 on ward.
- Fruit preservation & Canning Institute established in 1949.

**Historical Account of food processing (India)**

- Govt. of India passed F.P.O. 1955
- Fruit & Nutritional Borad established in 1973 for Licensing.
- Govt. of India establish APEDA at New Delhi and N. H. B. at Gurgoan for promotion of processing.

**Value added products prepared from fruits**

| | |
|---|---|
| Papaya | Jam, Candy, Nectar, Pickle, Sauce, Canned papaya, Papain |
| Grape | Wine, Juice, Raisin, Munakka |
| Karonda | Pickle, Jeely, Candy, Preserve |
| Banana | Canned banana, Dried banana, Toffee |
| Fig | Dried fig |
| Loquat | Jam, Jelly, Canned laquat |
| Ber | Candy, Preserve, Canned ber, Jam |
| Bael | Preserve, Nectar, Squash, Canned bael, Cider |
| Phalsa | Juice, Squash, Syrup |
| Juck fruit | Pickle |
| Citrus fruits | Juice, Pickle, Maemalade, Squash, Cordial, Candy |
| Jamun | Jelly, Syrup, Vinegar |
| Strawberry | Jam, Juice |
| Mulberry | Jam, Squash |
| Apple | Jam, Preserve, Juice, Chutney, Cider |
| Cheery | Jam, Candy, Canned cherry, Dried cheery |
| Peach | Jam, Chutney, Canned and Dried peach |
| Pear | Jam, Chutney, Pickle, Preserve, Canned pear |
| Plum | Jam, Chutney, Sauce, Dried plum |
| Apricot | Jam, Chutney, Canned and Dried apricot |
| Date | Dried date |

**1.Present Scenario of Processing industry in India**

The product profile of the fruit processing industry has remained static and is dependent only on a few fruits like mango, pineapple, citrus, tomato and peas. The production of new products besides being necessary for the survival and growth of the processing industry would also meet new taste and demand in home as well as export market.

**2. Availability of raw material**

As stated earlier a wide variety of fruits are cultivated in India and are available in abundance in the season. Some of these fruits like mango, guava, sapota, banana, cashew nut, jamun, pineapple, aonla and jackfruit do not grow in many countries and their products are likely to find a ready market in foreign countries. A contract between growers and the processing units would ensure the continued availability of good quality raw materials, at predetermined rates, to the industry.

**3. Manpower**

India is in an advantageous position, as compared to developed countries, in having a large reservoir of manpower, but skilled manpower in some trades is in short supply and productivity in general is low. Proper training, in-factory or institutional, good working conditions and reasonable wages would go a long way to increase productivity.

**4. Capital**

In recent years, with Government support, a number of big industries have diversified into the area of fruit and vegetable processing. There is, however, scope for food processing in smallscale units, which require less capital.

**5. Lack of awareness:**

Most commercial fruit growers are not aware of the market for preserved products and do not have the necessary technical knowledge to undertake processing themselves. The Central and state Governments have started a number of projects to impart different levels of training in canning and preservation.

**6. Marketing facilities:**

Although there is a demand for preserved products, which is likely to grow in future, these are not readily available in small towns due to reluctance of shopkeepers in stocking such items. The establishment of growers co-operatives would help in the marketing of such products and it is the policy of the Government to encourage the establishment of such co-operatives.

**7. Transport facilities:**

Earlier, the rapid transportation of fruits in good condition from one part of the country to another for processing was a serious problem because of paucity of roads, their bad condition and shortage of trucks and rail wagons. There is now considerqable improvement in both road and rail transport and the day is not far off when even remote rural fruit producing areas will be connected to processing factories in distant parts of the country.

Bottles and cans are the two major types of containers required by the food processing industry. Earlier these had to be entirely imported, but now the manufacture of bottles of the required specifications has been taken up by a number of factories. At present there is a great difficulty in the availability of cans since there are very few factories for their manufacture. Metal Box Company of India is the premier manufacturer, with factories in different parts of the country. There is need for setting up more factories to meet the demand for cans.

**8. Publicity**

Proper publicity is the only way to attract the consumers and give them information about the new products in the market. Publicity of the preserved food can create a good market even in backward areas, as a majority of the population does not have knowledge of these products. Displaying in exhibitions and fairs, by practical demonstrations and distributing samples to the public, can also popularize these products.

**9. Role of Government:**

Both the Central and the State Governments are giving encouragement to the fruit preservation industry by establishing food industries.

**Appropriate and viable technologies for fruit processing :**

**Thermal Processing:**

Thermal processing is applied in various food processing techniques including canning, bottling, aseptic packaging etc.

**(1) Canning:**

Canning may be defined as heating and sealing of the food material in a hermetically sealed container. Mango pulp accounts for the majority of the canned fruit products. Canning is also used for other products such as guava pulp, orange juice, pineapple slices, potato, tomato paste, puree, juice, green peas, beans, mushrooms etc.

**(2) Bottling:**

Ready to serve (RTS) fruit juice beverages are the most popular bottled products. The beverages can be made from a wide variety of fruits viz. mango, orange, pineapple, litchi, guava, apple, lime etc.

**Aseptic Packaging:**

High temperature short time heat processing. The main steps of aseptic processing involve sterilization, holding, cooling, chilling and filling.

**Freezing:**

It is low temperature preservation process where the product is frozen at - 40$^0$C and stored at -20$^0$C. Frozen products are closer to fresh products. Freezing methods viz, plate freezing, blast freezing and Individual Quick Freezing (IQF) are commercially used for different fruit products. The advantages of IQF are better retention of sensory quality, texture and reconstitution properties due to quick freezing.

**Concentrates:**

Preservation of single strength juice/pulp is not economical. It is advantageous to concentrate them. Membrane processing of fruit juices has specific advantages such as energy efficiency, clean process, retention of flavours and nutrients. Membrane process is a separation process, which does not involve phase change. Fruit pulps are treated with pectolytic enzymes and passed through membrane system to obtain the clarified juices. Pineapple, orange, pomegranate, papaya etc can be clarified and concentrated by this technique.

**Drying and Dehydration**:

Drying has been as age-old practice used to preserve food. The main principle of drying is removal of water, which is required for microbial growth. The major dehydrated products includes peas, onions, raw mango powder and fruit candies. Sophisticated modern drying technologies such as vacuum shelf drying, freeze drying, fluidized drying are used for specific products.

**Hurdle Technology**:

The technology involves application of a combination of treatments such as heating, drying, reducing water activity, pH, addition of preservatives and other additives The combination of hurdles used for preserving a food product disturb the homeostasis of the microorganisms, thereby, retarding the growth resulting in microbial stability.

**Minimal processing**:

Minimal processed foods, as itself indicates, are treated very mildly with various treatments, packed in polymeric films and stored at low temperature such the quality resembles fresh like character. The color, texture and flavour are not altered significantly in the minimally processed products.

**Beverages**:

Fruits such as mango, orange, grapes, acid limes, passion fruit, banana, guava, pineapple, papaya, litchi, apple and pomegranate can be utilized to prepare RTS beverages. During the season, the pulp/juice of these fruits can be preserved suitably and utilized later for preparing the beverages.

**Jams and jellies**:

Jams and jellies are popular fruit products. Jams can be prepared from pineapple, mango, mixed fruits, strawberry, grape and apricots, while jellies from guava, lime, strawberry etc. Superior quality products can be prepared by continuous process in vacuum evaporator. For this, the feed composition has to be suitably modified to obtain the desired end results.

**Candied, Crystallized and glazed fruits**:

Candied fruit products can be prepared from raw papaya, pineapple, banana, amla, apple etc. The process consists of preparation of fruits, peeling, cutting and cubing, impregnating sugar by cooking slowly to $70^0$ brix, acidifying and draining the syrup.

**Liquid fruits:**

Pulpy fruits such as mango, guava, banana and papaya can be liquefied to obtain clear juices by treating them with Pectinase enzyme. The products have full flavour and can be converted into beverages of blended beverages.

**Waste management and by-products utilization**

The growth of fruit and vegetable industry in India has brought forth the problem of effective disposal of wastes. According to the degree of pollution, the organic waste generated can be divided into:

- One relating to volume and characteristics of wastes
- The other relating to the conditions, the number and duration of processing cycles in a year.

**By-products utilization:**

About 10-60% solid waste is generated from the fruit processing industry. Efforts are being made to utilize the waste to produce value added products. Some of the important by products include citrus oil, pectin from citrus peel, fiber from pineapple, fat from mango kernel etc. Utilization of waste is very important for the processing industry for the disposal of waste as well as achieving high percentage of raw material utilization. Technologies for producing pectin from citrus peel, fat from mango kernel, papain from papaya latex, natural colours from blue grape, lycopene from tomato waste, biogas from processing waste etc, are available.

**Importance of HACCP, GMP, ISO in fruit processing**

After the WTO agreement and Globalization it is obvious that any product manufactured can be marketed anywhere in the globe provided a quality and acceptability of the product is met with competitiveness in price. Hence the importance of total quality monitoring systems like Hazard Analysis and Critical Control Path (HACCP), Good Manufacturing Practices (GMP), International Organization of Standards (ISO) 9000/2000 series and so on. A concerted effort is needed in this direction to install appropriate Total Quality Management (TQM) System in growing, harvesting, transportation, processing and storage and distribution areas. Knowledge of organic farming and insecticide and pesticide residues etc will help the farmers and processors to go in for high-tech cultivation and scheduling of handling and processing of the commodities.

**Points need debate and follow up actions**

- Action plan need to be initiated to keep the freshness of the produce by application of all available scientific concept & technologies and processes of farm to consumer-An integrated system approach.

- Application of appropriate technology for pre-packing and setting up of grading and packing houses in built with cold chain for storage and distribution.

- Application of appropriate technologies for value addition to the abundantly grown produce like mango, guava, amla, phalsa and anona.

## Processing and value addition in vegetable crops

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The Vegetable production of our country before independence was very low a meagre 15 million tonnes which increased to 23.45 million tonnes in 1961-65 to 28.36 mt in 1967-71 and to 39.99 mt in 1986 and so on to the present level of about 91 million tonnes. Thus in the past 4 decades the country has made commendable progress in the field of vegetable production brought about by creation of infrastructure for research and development enabling second position in vegetable production in the world next to China. Presently vegetables occupy 6.5 million hectares with production of about 91 mt. Due to advent of hybrid varieties and general awareness of nutritional security among the people, vegetable production in our country has gained momentum. The credit for this vertical expansion in vegetable production goes to improved varieties/hybrids and newly emerging production and protection technologies. However, as the country's population is increasing @ 1.6 per cent each year, our vegetables production is targetted to around 150 million tonnes by the year 2010.

**Area, Production and Yield of Vegetable Crops in India**

| Year | Population (million) | Area (m.ha) | Yield (t/ha) | Production (m.t) | Availability /caput /day(g) |
|---|---|---|---|---|---|
| 1990-1991 | 844 | 4.50 | 10.00 | 45.00 | 135 |
| 1999-2000 | 1017 | 6.50 | 15.00 | 100.00 | 200 |
| 2009-2010 | 1263 | 8.00 | 20.00 | 150.00 | 225 |
| 2019-2020 | 1566 | 9.00 | 25.00 | 200.00 | 250 |
| 2024-2025 | 1745 | 10.00 | 30.00 | 250.00 | 300 |

The larger share of the production is consumed internally while only a tiny portion goes into processing and value addition. Though our country is world's second largest producer of vegetables yet hardly 2 per cent of its production goes into processing. This is due to lack of infrastructural facilities in the country which account for nearly 30 per cent post harvest losses annually.

**Estimated Post Harvest Losses of Vegetables**

| S.No. | Vegetables | App.Loss(%) | Source |
|---|---|---|---|
| 1. | Tomato | 5-50 | Meena &Yadav(2001) |
| 2. | Onion | 16-35 | Meena &Yadav(2001) |
| 3. | Brinjal | 8.0 | Subramanium(1986) |
| 4. | Okra | 9.4 | Subramanium(1986) |
| 5. | Potato | 5-40 | Meena &Yadav(2001) |
| 6. | Cabbage | 37 | Meena &Yadav(2001) |
| 7. | Cauliflower | 49 | Meena &Yadav(2001) |

Such losses can be prevented bu efficient post-harvest mangement technologies such as grading, packaging, pre-cooling , storage and transportation. Vegetables are highly perishable in nature and can not be stored at room temperature for longer period. However tomato is one of the widely grown vegetable in the country and the world, which is why it has gained wide popularity both as fresh and processed vegetable resulting in higher production . This increase in production often leads to market glut, wastage and economic losses to the growers. Storage at low temperature in cold storage is highly expensive. Hence only post harvest management enables extended storage life of tomato with quality maintenance. One of the methods is harvesting at earlier stages than fully ripe for fresh market and secondly slowing down the ripening process.

Etharol has been found to be an effective inhibitor of tomato ripening without affecting the quality. There are also other methods of saving tomatoes such as their conversion into various products for value addition such as juice, jam , canning , sauce, ketchup, soup, chutney, paste and cocktails.

Similarly the storage life of chilli fruits can also be enhanced through packaging and storage. The shelf life of chillies thus can be increased by packaging green coloured chilli fruits in polyethylene bags and storage in cool chamber. In this way the green chillies stay fresh and marketable which is an advantage over room temperature.

**Scope for Processing and Preservation in India :**

In spite of the great economic importance and wide scope, this branch of food technology has not received the impetus, it deserves . Therefore, if it is to be developed in proper perspective, the following proplems are to be dealt within right earnest.

(i) Availability of raw material

(ii) Labour problem

(iii) Capital
(iv) Lack of interest and scientific knowledge
(v) Marketing facilities
(vi) Transport facilities
(vii) Availability of cans and bottles
(viii) Publicity of the product
(ix) Role of the Government.

**Value Added Products :**

The prominent items processed in the fruits and vegetable processing segment are pulps, juices, canning, jams, pickles & chutney. Of late, the processing industry has taken up processing of frozen pulps and vegetables, freeze dried vegetables, preserved garlic, ginger and onion paste. The canvas of processed vegetables is likely to expand further in the years to come. Conventionally dried vegetables lose their structural intergrity and reveal poor rehydration traits, the freeze dried or the dehydrated ones retain their texture and colour and reconstitue fairly quickly in cold water owing to the porosity. A wide range of fruits and vegetables can be freeze dried in puree or pulp/ paste form. Fruits and vegetables and the products with initial moisture content of as much as 90 percent take only a day to be freeze dehydrated to a moisture as low as 2 percent owing to low moisture content and presence of salts and sugars in them. Freeze dried vegetables are hygroscopic in nature, require their packaging under controlled conditions of humidity, which are also not threatened of any microbical growth. The products thus remain shelf stable under ambient conditions for as long as a year without spoilage when neatly packed .

Treating blanched cauliflower with salt and sucrose for 12-16 hrs markedly reduced shrinkage and improves rehydration without affecting palatability and improving the shelf life of the dried product. Brinjal, Cabbage, Bittergourd and Kundru also showed improvement in dehydration and reconstitution with similar treatment with varying concentration of salt & sucrose. Improved dehydration techniques are highly effective in preserving vegetables.

**Potato**

Potato is another crop which is used in various product forms such as dehydratioin chips, french fries and canned. Nearly the entire production of potato is utilized as human food with only 10% are used as seed and another 15% lost at various stages. There are various constraints in the storage as also marketting which leads to spoilage . This could be reduced through processing. Potato tuber contains nearly 80% water & 20% dry matter. The starch content is about 14% & sugar content is about 2% on fresh weight basis. Potatoes contain high dry matter and are suitable for fried & dehydration products while those having low dry matter content are meant for canning. A dry matter content less than 18-20% is good for canning but for chips. For french fries & dehydrated products the ideal dry matter content is more than 20% . Late maturing varieties contain high dry matter as compared to early maturing varieties. A reducing sugar content close to 250mg/100g fresh weight is considered suitable for producing chips while for french fries, canning and dehydrated products reducing sugar to the extent of 500mg/ 100g fresh weight is highly acceptable.

**Products Prepared from Vegetables :**

| S.No. | Vegetables | Products |
|---|---|---|
| 1. | Tomato | Sauce, Chutney, pickle, puree, paste,canned tomato juice, soup and jam |
| 2. | Cauliflower | Pickle and dehydrated |
| 3. | Carrot | Jam, preserve, pickle, candy and canned |
| 4. | Peas | Canned and dehydrated |
| 5. | Green Chilli | Pickle |
| 6. | Radish | Pickle |
| 7. | Ash gourd | Candy |
| 8. | Bittergourd | Dried powder |
| 9. | Garlic | Pickle and powder |
| 10. | Beans | Canned and dehydrated |
| 11. | Ginger | Pickle, preserve and dried |
| 12. | Watermelon | Juice, squash and Jam |
| 13. | Muskmelon | Juice, squash and Jam |
| 14. | Mushroom | Pickle, sauce, canned and dried |
| 15. | Potato | Chips, wafers, powder, soup, french fries and cubes |
| 16. | Onion | Dehydrated |
| 17. | Sweet potato | Pickle, jam, jelly, squash |
| 18. | Coriander Fenugreek & Mint | Leafy powder |

**Processing Methods of Vegetables**

Vegetables are a major source of vitamins and minerals. Since they are highly perishable, they need to be preserved and processed in various value added products.

**1. Heat Preservations & Processing :-**

Heat is widely used in preservation of fruits and vegetables by cooking , microwave heating, canning, pasteurization, boiling or heating prior to consumption. In these processed foods, both pathogenic and toxin producing organism are destroyed . Enzymes are also heat sensitive. By the application of heat both microbial and enzymatic spoilage can be well checked .

2. **Low Temp. Preservation and Processing :-**

Freezing and cold storage are the oldest methods of food preservation. Commerical and house hold refrigerators are usally run at 4.4 to 7.2$^0$C, whereas in frozen storage, frozen condition is maintained at zero degree or below. Refrigerated or cool storage preserves perishables for days or weeks depending upon the commodity. Frozen storage preserves perishables for months or even years because of very low temperature. The methods used are:-

- Freezing -Cold storage
- Frozen Storage

**3. Preservation by removing moisture :-**

Drying ( removing of moisture) helps in preservation of fruits & vegetables. Microbes cannot grow and multiply in absence of sufficient water in their environment. Fruits and vegetable may be dried in air, super heated steam, in vaccum in inert gases or by direct application of heat by :-

- Drying and Dehydration
- Preservation with sugar- jam , jelly , candies
- Preservation by salt
- Preservation by food additives
- Chemical preservation
- Preservation of beverages
- Processing of sauce, chutney & ketchup

**Drying Schedule for Vegetables**

| Vegetables | Preparation | Blanching in boiling water (minutes) |
|---|---|---|
| Peas | Shelled peas | 2-3 (in boiling water contain ing 0.5% KMS ,0.1% sodium bicarbonate and 0.1% magne- sium oxide) |
| Bittergourd | Remove both ends and cut into 6mm thick slices | Blanch in boiling water for 7-8 minutes |
| Cabbage | Remove outer ends and cut into 4-8 mm thick shreds | 5-6 |
| Cauliflower | Remove stalks, leaves and stem,cut into 10mm thick pieces | 2-4 (in salt solution of 2-4%) |
| Fenugreek | Sort, remove leaves , stalks | Same as for peas |

| | | |
|---|---|---|
| | and stem and wash thoroughly for 2-3 minutes | |
| Garlic | Peel the cloves, cut into 6mm thick shreds | NIL |
| Knol- Khol | Peel, cut into 5mm thick slices | NIL |
| Onion | Remove tops and tails, peel adn cut into 4-8 mm thick shreds | Dip for 10 minutes in 5% salt solution |
| Okra | Remove both ends and cut into 6mm thick slices | 5-6 |
| Beans | Cut into small length | same as for peas |
| Potato | Peel, cut into 3-5mm thick slices | 3-4 |
| Pumpkin | Peel, remove seeds and soft portions, cut into 6mm cubes | 2 minutes in hot brine (2% common salt solution) |
| Spinach | Sort, wash thoroughly in water and cut into 10mm portions | Same as for peas |
| Tomato | Peel after scalding in boiling water for 30-60 seconds and make slices of 6-9 mm thickness | NIL |
| Turnip | Peel and cut into 4-7mm thick slices | 2-4 |

**4. Preservation by Fermentation :-**

Fermentation is low cost technology for preservation of fruits and vegetables. The fermentation of foods have many advantages such as prolonged shelf life, extended seasonal life, less time for cooking, and some time for increased acceptability and digestibility. Fermented spiced beverage from black carrot is very popular in North India.

**Use of Preservatives in Different Products :**

| Name of Product | Name of Preservatives |
|---|---|
| Pickle & Chutney | Sulphur dioxide & Benzonic acid |
| Sauces | Benzoic acid |
| Dehydrated vegetables | Sulphur dioxide |
| Tomato Puree & Paste | Benzoic acid |
| Syrup & Sharbats | Sulphur dioxide or Benzoic acid |

In case sulphur dioxide is used as preservative in pickles and chutneys, the products should not be packed in tin containers.

**5. Cold Sterilization and Irradiation**

The spoliage of fruits & vegetables can also be controlled by ionizing radiation. Irradiation technique can also be used of checking sprouting of roots, tubers and bulbs.

**Vegetable Varieties Suitable For Value Added Products**

Nature has given our country varied agro- climatic conditions to grow a large spectrum of vegetables from temperate to humid tropics and from sea level to high altitudes. Further concerted research efforts have led to develop a plethora of varieties which are more than 250 besides a number of improved technologies in different vegetable crops. Hybrid varieties though of recent origin in this country are spreading far and wide and cover large areas. Hybrid tomato is most sucessful in Karanataka, Maharastra, Gujarat and parts of Andhra Pradesh while hybrid cabbage production is in southern part of Maharashtra and West Bengal. Among these some of the varieties and hybrids are suitable for processing. A few of significant varieties/ hybrids in different vegetables crops are listed in following table.

| Crop | Purpose | Suitable varieties / Hybrid |
|---|---|---|
| Onion | Dehydration, Fermentation Brining | Baswant -780, Phulesuvarna, Phule Safed, Kalyanpur Red Round & Arka Pitamber |
| Garlic | Paste | PG- 20, PG-17, Hissar arun, Phule Hybrid-1, |
| Tomato | Puree | JKTH-895, Kalyanpur Angoorlata, Azad T-6, PR-3, PR-4, Arka ashish, Kalyanpur Type-1 |
| Patato | French fries | Kufri Chipsona-1 Kufri Chipsona-2 |
| Palak | Dried | IIHR Sel -12 |
| Coriander | Dried | IIHR-13 |
| Peas | Canned / Dehydrated | Marrow Fat, Azad P-1, Azad P-3 |

**Export of Processed Vegetables**

Processed fruits and vegetables are a good source of export earning and command a lion share of more than 27 per cent in total value of export by way of dried and preserved while other processed fruits and vegetables have nearly 8 per cent share. As such these processed export items have great future and efforts, therefore, have to made to streamline the industry in the wake of more openings and globalisation & liberalization.

## Postharvest Problems of Horticultural Produce

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Fruits and vegetables are known to be one of the essential components of our diet. These are the rich sources of a variety of nutrients including vitamins, trace minerals and dietary fibre. Epidemiological data support association between high intake of fruits/ vegetables and low risk of chronic diseases. Because of its diverse agro-climatic conditions, ranging from tropical to temperate, India has the distinction of being second largest producer of fruits and vegetables. This is indeed the bright side of our horticulture sector but the flop side of the situation is that because of their perishable nature fruits and vegetable suffer heavy losses (Table-1).

**Table 1: Post harvest losses of some crops in developing countries**

| Crop | Estimated Loss (%) | Crop | Estimated Loss (%) |
|---|---|---|---|
| Apple | 14 | Citrus | 20-95 |
| Avocado | 43 | Grapes | 27 |
| Banana | 20-80 | Papaya | 40-100 |
| Cabbbage | 37 | Potato | 35-100 |
| Carrot | 44 | Stone Fruits | 28 |
| Cauliflower | 49 | Tomato | 5-50 |

The reason for these losses are of microbial, physiological or physical nature. Further packaging, grading and transportation also contribute to these losses. Another dark aspect of Indian horticulture is that only two per cent of our horticultural produce is processed into commercially important products as against more than 40 percent in many parts of the world. (Fig. 1). The infrastructural facilities available in our country are not utlized to the full capacity because of many reasons especially seasonal availability of the raw material.

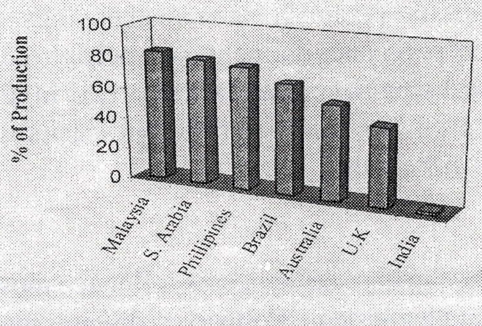


Fig.1: Percent of Produce Processed

**Changes in Harvested Produce:**

A number of physiological and biochemical processes occur in the harvested produce that contribute to damages in its palatability. Physiological changes occuring in the fruits after harvest are attributed to the biochemical hydrolysis of starch and accumulation of sugars, disappearance of acidity, degradation of green colour and development of other colours like yellow or red etc. (Table 2).

**Table 2: Changes in Harvested Produce During Storage**

| Changes | Process | Example & Signifance |
|---|---|---|
| Water Loss | Transpiration Evaporation | Unattractive apperance, texture changes, Weight loss, shriveling. |
| Carbohydrate Conversion | Enzymatic | Starch to sugar; detrimental (Potatoes), Beneficial (Banana). |
| Flavour | Enzymatic | Beneficial (Banana & Pear), detrimental also |
| Softening | Enzymatic | Detrimental. |
| Colour | Pigment Synthesis /Destruction | Detrimental or beneficial. |
| Pith/fiber Development | Growth & Development. | Detrimental in root crops. |
| Sprouting | Growth & Development. | Detrimental in potato, onion, asparagus. |
| Decay & Rot | Microbial | Detrimental. |

Degradation of pectin during storage by various pectinases is the process responsible for softening of the fruits like apple, pear, guava etc. Sprouting of vegetables like onions, potatoes etc. during storage also reduce their acceptability. Water loss from the produce due to evaporation and transpiration results in unattractive appearance, weight loss, texture changes, shrivelling etc. Transformation of carbohydrates during storage is detrimental in some crops like potato where as in other crops like banana & pear it is beneficial. The environment of produce during storage needs to be manipulated in such a way that all the physiological activities proceed at a slow rate. In addition to manipulation of environment, some chemicals like harmones (MH) and calcium chloride can be used to alter the course of changes in the fruit.

**Post harvest Diseases:**

Decay losses or the threat of decay losses influence most aspects of modern fresh horticultural crops handling systems. Postharvest diseases must be considered while selecting handling practices or methods. Therefore, an understanding of disease organisms, the host commodity and the relation of handling methods both is of critical importance. The major means of spread of diseases as fruits approach maturity and after harvest is the vegetative spore. The spores after germination penetrate into the host either through wounds or with the help of appresoria. Once penetration has succeeded, the mycelium grows and branches to thoroughly invade the fruit. The advancing mycelium may excrete toxins into the fruit and also produce many enzymes especially cell wall degrading enzymes. Some of the important post harvest diseases and their causal organisms are given in Table 3.

**Table 3 : Principal Postharvest Diseases of Pome Fruits**

| Disease | Pathogen | |
|---|---|---|
| | Conidial State | Sexual State |
| Gray mold | *Botrytis cinerea* | *Botryotinia fuckeliana* |
| Blue mold | *Penicillum expansum* | -- |
| Bull's-eye rot | *Cryptosporiopsis curvispora* | *Neofabria malicorticis* |
| Bitter rot | *Colletorichum gloeosporiodes* | *Glomerella cingulata* |
| Black rot | *Sphaeropsis malorum* | *Botryosphaeria obtusa* |
| White rot | *Dothiorella gregaria* | *Botryosphaeria dothidea* |
| Alternaria rot | *Alternaria alternata* | -- |
| Cladosporium rot | *Cladosporium herberum* | -- |

Despite the magnitude of the problem, plant pathologists have not given postharvest diseases the priority they warrant. This, probably, is due to an abundant food supply in developed countries that masks the severity of post harvest losses. A number of fungicides are in use for control of post harvest diseases of fruits. But thses fungicides are becoming less effective as the pathogens develop resistance against them. Also, recent health concerns over pesticide contamination of food have precipitated the complete withdrawl of a number of key fungicides from the market. To have an ecofriendly & sustainable control system of pos tharvest diseases, the concept of induced resistance is being exploited where in biological and physical elicitors are exploited.

**Physiological Disorders:**

Fruits suffer from many physiological disorders during their storage. Most of the tropical fruits when stored at temperature of 5-15$^0$C suffer from chilling injury. The effect of chilling injury at cellular level is that membrane compartmentalization gets disturbed drastically. The symptoms that appear on the fruits include surface and internal discolouration, pitting, water soaked areas, uneven ripening, off flavour development, wooliness or mealiness etc. Another low temperature dependent storage disorder of fruits is freezing injury which occurs when the fruit is stored at a temperature below its freezing point. The injury occurs due to the formation of crystals which damage the cell wall by penetrating into the cells. Sometimes high temperature also results in some disorders which include bleaching, surface burning or scalding, uneven ripening, excessive softening, desiccation etc. Imbalanced nutritional status of the soil may also result in many storage disorders of fruits. Calcium deficiency results in many serious disorders like bitter pit or water core. Oxidation products of farnesene have been reported to cause superficial scald during controlled atmospheric storage of apple. Some chemicals like sulphur dioxideand ethylene dibromide result in toxic effects on fruits during storage.

**Some General Problems:**

In addition to above mentioned problems fruit industry faces some general problems with respect to post harvest handling/storage and processing. These problems include:
- Non availability of proper infrastructure
- Limited air space with high rates of freight
- Lack of appropriate raw material for processing
- Variation in quality of raw material
- Comparatively low productivity
- Prohibitive cost of finished product
- Lack of trained manpower in processing sector
- Financial and fiscal constraints
- Non utlization of wastes

**Needs under present scenario:**

Globalization of market has changed the scenario of Indian agriculture. It has indeed given some opportunities to our farmers but at the same time it may result in creation of some problems. Under such circumstances it becomes essential for all those who are concerned with horticulture or fruit processing sector to consider the following points :

- Product safety
- Ecofriendly & sustainable technology
- Competitive product & technology
- Consideration of product life cycle
- Characterization of local germplasm
- Awareness about IPR
- Proper quarantine
- Use of IT for efficient market intelligence
- Establishment of proper linkages
- Consideration of products with export potential

**Biotechnological Approaches:**

Biotechnology offers some more convenient and easy solution to many of the problems of horticultural produce. With better understanding of the biochemical and physiological aspects of fruit ripening, many successful attempts have been made to control these processes at genetic level with an objective of extending the post harvest life of the produce. For slow release of ethylene genes governing the activity of enzymes like ACC synthase and ACC oxidase are being targeted as these two enzymes play very essential role during biosynthesis of ethylene. Similarly genes governing the activity of polygalacturonase (PG) are also the target of biotechnologists as PG is responsible for degradation of pectin and consequently softening of fruits.

Many enzyme based processes are utilized for processing of different fruits and vegetables. In fruit processing industry enzymes are extensively used for getting better juice yields and clarification of juices. Debittering of various citrus juices is also achieved by using various microorganisms or enzymes produced by them. Enzymes of microbial cell based processes can also be used for nutritional improvement of various fruit products.

**Post harvest - A Multidisciplinary Approach :**

The major spoilage agents for fruits are enzymes, microorganisms, pests and the environmental factors. So to have a better understanding of all these aspects, a sound knowledge of relevant disciplines is a must. Thus to be an effective post harvest technologist, it is essential to have sound knowledge of horticulture, nutrition, microbiology, biochemistry & physiology, food science & technology and engineering. Even molecular biology and genetic engineering is finding increasing usefulness to solve the post harvest problem of horticultural produce. Biochemically and physiologically, the post harvest physiologist is mainly concerned with slowing down the rate of respiration. Thus post harvest technology is a multidisciplinary subject encompassing several sub disciplines (Fig. 2).

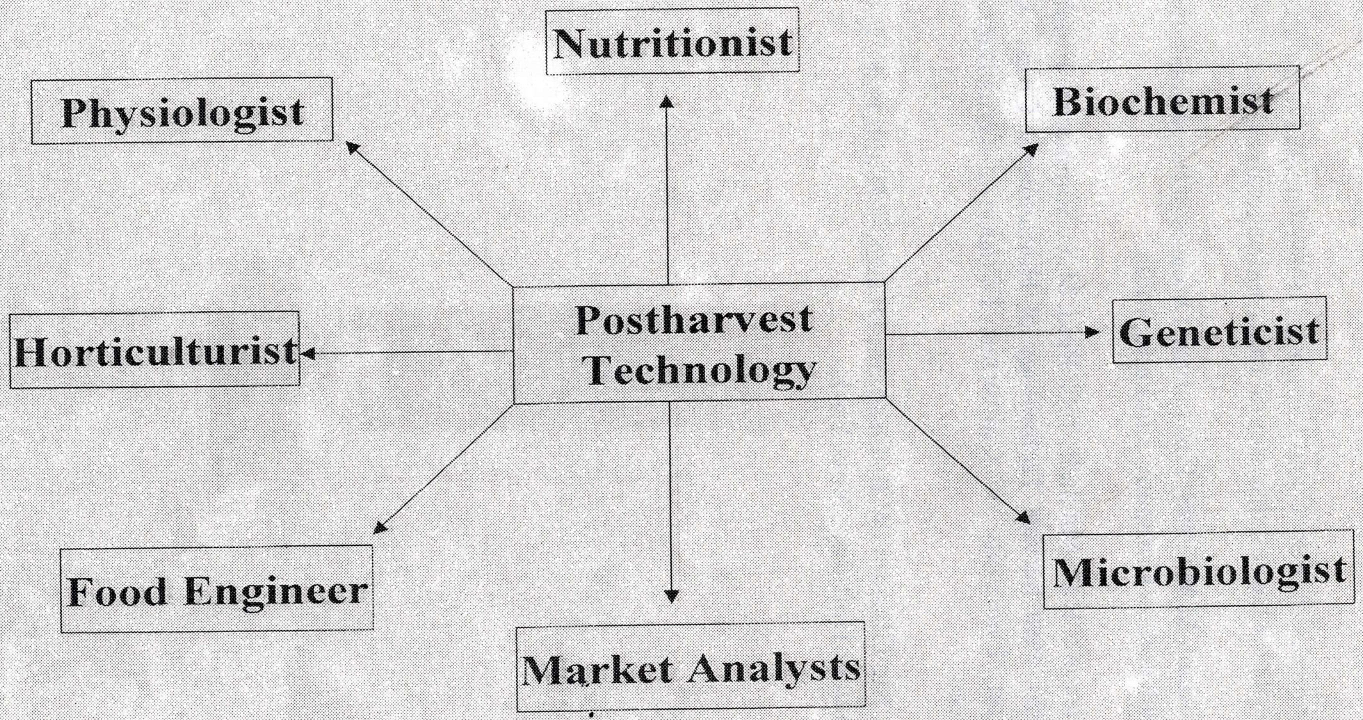


**Fig. 2: Postharvest-A Multidisciplinary Approach**

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# Processing of Fruits and Vegetables for Value addition under Changing Marketing Scenario

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India is a country with a population of 1000 million out of which 350 million live in urban areas. For this urban population, processed foods will become their main stay sooner or later. Food processing industry has been termed as **'Sun rise industry'.** Several efforts have been made in the last few years to give thrusts to this sector. Food processing industry ranks 5th in size in the country representing 6.3 per cent of GDP. There are around 9000 organised units in the country.

India produces about 45.37 million tonnes of fruits and 93.92 million tonnes of vegetables anually, which is next only to China. With the exception of vegetables and potatoes, most of horticultural crops are grown in dry land areas. For efficient cultivation of dry land areas, horticultural crops have a major role to play in agriculture. These horticultural crops are grown in only 8-9 per cent of the gross cropped area of 165.5 million hectares. They contribute more than 18.84 per cent of the gross value of agriculture output and about 52 per cent of export earning of total agriculture produce. Fruits and vegetables cover 72 per cent of the areas and 92 per cent of production of horticultural crops.

In Himachal Pradesh 21 per cent of total cropped area is under horticulture. Apple is the main crop, which constitute more that 85 per cent of total fruit production. Other fruits grown are pear, peach, plum and apricot. In lower hills, fruits like mango, litchi, guava and citrus are the major fruits. The new fruits coming up in hills are kiwi, strawberry, grapes and berries. There is a tremendous scope for further increasing the production of chilgoza (neoza), dry appricot, saffron, apricot, raisins of good qualities which is a monoply of dry and high hills. In case of vegetables, Himachal Pradesh produces about 6 lakh tonnes of vegetables with 1.2 lakh tonnes of potatoes followed by tomatoes, ginger, peas, beans, cauliflower, cabbage, capsicum, etc.

Main emphasis in Himachal Pradesh is for the cultivation of fruits and vegetable crops for fresh market and less emphasis was given on processing suitability. At present more than 90 organised fruit processing factories with processing capacity of 25,000 tonnes annually (6-7 percent of production) which is higher than national average (>5000 factories with >21.0 lakh tonnes of capacity) but lower than advance countries, where the figure ranged between 70-83 per cent. The reduction in post harvest losses is complementary means of increasing food production. To reduce the waste during seasonal gluts, ensure better returns to growers and provide better nutrition to nation, fruits and vegetable-processing industry is of vital importance. The un-necessary wastage of valuable commodities can be avoided if they are processed in time in value added products. There is great scope of domestic and export trade by improving the post harvest distribution and processing facilities of these highly perishable horticultural commodities. A massive thrust to fruit and vegetable processing industry will add value to product thereby increasing the income of farmers, create employment opportunity, and to diversify the rural economy and foster the rural industrilization. The demand for processed food is likely to multiply significantly in the coming years. Rapid urbanization, breakdown of joint family system, increase in the cost of household labour, increase in number of working women, rise in per capita income have all contributed to the rapid growth and change in the demand pattern.

**Processing:**

Fruits and vegetables are living entity which are highly perishable in nature and have short shelf life. Due to lack of proper postharvest management and processing facilities in India around 20-40 per cent go waste annually. The processing of fruits include washing, removal of inedible parts, removal or destruction of potentially harmful substances and preservation. It also includes simple cooking which tend to reduce to some extent, the nutrient content or quality of foods. Modern processing methods are assigned to keep such losses as low as possible. In many instances nutrients are restored by enrichment after processing. Processing can help prevent losses by inactivating enzymes or microorganisms present in food.

**Value Addition:**

It may be defined as the process by which a fresh commodity is altered in such a way that it offers greater convenience for handling, transportation, storage and consumption. It may or may not involve processing or addition of various additives but must definitely add to its nutritional value or economic returns.

**Importance:**

The backbone of horticulture is the fruits and vegetables processing industry as it takes care of gluts and wastes of fruits and vegetables. Processing and value addition provide additional income to growers, prevents the fluctuations of the prices and distress conditions of the orchardist with better economic returns.The best overall indicator of the economic contribution of fruits and vegetables processing to the food system is the value addition. It represents the firm's contribution to an industry's value addition and value addition is the indicator of industry's contribution to Gross Domestic Product (GDP).

**Export:**

The horticultural crop can play a potential role in ensuring more remunerative returns per unit input (land, water, fertlizer, pesticides etc.) and in planning effectiv e utilization of the available wastelands in India. There are many European and East Asian countries who are looking forward to us as a major source of supply of fruits and vegetables, both in fresh and processed form. Given our untapped,but undeniable resources we are in position to wrest a significant share of the golbal market at this point of time. But delay can make our penetration difficult as the competition is very high and other competitors will grab a lions share. Penetration in non-conventional markets needs the knowledge of:

* Commodities in demand and specification according to consumer need and preferences.
* Season during which supply is less than demand.
* Regulation pertaining to import, export, quarantine and other allied pertinent matters.

Processed food product worth 12,245/- crore were exported from India during 2000-2001 of which 525 crore was contributed by processed fruits and vegetables. Trade in the preserved fruits and vegetables consists largely of fruits and vegetable juice, concentrate, nectars, paste, canned pineapple, semi-processed fruit pulps and berries, canned and dehydrated vegetables.

Frozen pulps and vegetables, freeze dried fruits and vegetables, fruit concentrate and aromas, packed vegetables, curies, tomato paste, potato chips and spice oleoresin are recently added. Out of the various products major market demand (62%) is for fruit pulps, RTS beverages, pickles, Jams and jellies.

India with great potential for producing competitive horticultural products can play a major role in domestic as well as world trade since there lies the right opportunity to promote and realize the market revolution and taking advantage of:

* Changing food habits.
* Emergence to new highly consumption markets like Japan.
* Our proximity to southeast Asia and Far East and logistic advantage as compared to other major exporters like South Africa and Chile.
* Our capability to produce significantly large quantities of fruits and vegetables under low input natural conditions.
* Reduction in tariff and non-tariff barriers.
* Liberalization of Indian economy and offered incentive for promotion of export horticultural commodities.

With the changing secnario of modernization and mechanization, the demand for processed products has increased manifold. As a result of WTO agreement , the whole world has become one market and improvement of products is important to compete in the world market. The fruit production in India has been growing at annual rate of 3.9 per cent while processing sector has been growing at the rate of 20 per cent per annum, in the recent years.

**Processing and value addition**:

Processing sector has a challenge to extend and expand the availability of reliable, safe, stable, tasty and economically processed fruit products in the market. It involves different treatments and processes in the transformation of fruits and vegetables in to an acceptable edible product having delicacy and high nutritive value. The major fruits and vegetables of subtropical and temperate areas are apple, stone fruits (peach , plum, apricot), mango, citrus, guava, pear, kiwi, strawberry, litchi, cabbage, carrot, cauliflower, tomato, potato, ginger, mushroom, radish, peas, cucumber etc. which are highly perishable and have short post harvest storage life.

**Export of processed fruits and vegetables**

| Product | Value (Rs. in crore) | |
|---|---|---|
| | 1998-99 | 1999-2000 |
| Dried and preserved vegetable | 380.24 | 589.89 |
| Mango pulp | 138.93 | 196.52 |
| Pickle & chutney | 74.01 | 89.98 |
| Other processed fruits & vegetables | 112.67 | 117.23 |

**Various methods like:**

* Membrane technology
* Enzyme Technology
* Aseptic processing
* Hurdle technology
* High pressure processing
* Freezing
* Freeze drying
* Irradiation
* Canning
* Spray drying
* Foam mat drying
* Vacuum puff dry

These methods involve heavy capital investment and products preserved by these methods are hygienic, nutritive and acceptable.

**Simple and low cost technologies for preparation of different products:**

**Dried Products**

The different fruits and vegetables are sun dried and their darkening can be prevented by $SO_2$ treatment and proper packaging e.g. dried apricot (chuli), dried apple rings and powder, mango powder (amchur), peas, potato, cherries, pepper, spices, vegetables like cauliflower, cabbage, bittergourd etc.

**Fruit Jam, Jelly and Marmalades**

Jam can be prepared from pulp of apple, peach,plum, apricot, mango, orange, kiwi and mixed fruit jam. Jelly is made by boiling the fruit juice extract with sugar to a clear gel e.g. apple, plum, orange, pear, guava, apricot, peach, strawberry. Marmalade is a fruit jelly in which slices of fruit or of the peel are suspended e.g. oranges and lemons.

**Chutney**

Can be of mango, apple, tomato, pear apricot, peach, plum fruits etc.

**Sauces and Ketchup**

These can be prepared from the tomatoes and its semi processed products e.g. paste, puree and juice etc.

**Pickles**

* In brine and vinegar e.g. vegetables, onion, lemon, ginger, mushroom etc.
* Lactic acid fermented pickles e.g. Sauerkraut (cabbage), raddish, cucumber, olive etc.
* Pickle in oil - Mango, spiced apple pickle, mixed vegetable pickle, (cauliflower, carrot etc.) garlic, anola, ginger, tomato.

**Fruit Pulp/Intermediate Technology:**

* Fruit pulp can be preserved by addition of 750-1000 ppm of $SO_2$ and further be used for preparation of different products such as jam, juice, nectar, squash toffee, leather, bar (mango, peach, plum, apricot, strawberry, and litchi).
* Raw mango, hill lemon and vegetables like cauliflower, bittergourd etc. are preserved in steeping solution for product preparation during lean season.
* Tomato Puree- For latter use for juice, concentrate, paste, ketchup, sauce, soup etc.

**Fruit Juice Beverages:**

* RTS (Ready to serve) beverages can be prepared from fruits like apple, plum, pear, mango, litchi, apricot and citrus etc.
* Juice Blends- various juice blends can be prepared in order to utilize cheaper papaya, pomegranate, peach, plum, apricot, carrot etc.
* Fruit squash can be prepared from apricot, plum, litchi, lime, orange, mango, pear, kiwifruit.
* Appetizers: can also be prepared from the fruits like plum, apricot, galgal and ginger.
* Cordial: Lime

**Preserve and Candies:**

Can be prepared from aonla, carrot, mango, ginger, apple.Citrus peel candy, ginger candy, apple and pear candy are most palatable.

**Alcoholic Beverages:**

* Alcoholic beverages from different fruits viz. apple, plum, peach, wild apricots and pear.
* Vermouth from apple, plum and sand pear.

**Quality consideration:**

International consumers are extremely quality conscious. Thus, aligning Indian Standards of bench marking quality with international standards could provide a boost to export of processed food products from the country. Realizing the need, there is an all around development in quality at every step in India. Consequently, the processors have started taking steps to improve quality right from the selection of raw material/ ingredients. Side by side step has been taken by them to upgrade the hygienic and sanitary conditions of the workers, plant and machinery so as to ensure the quality of the finished product. There is greater emphasis now to invest in R&D and product innovation. There is worldwide interest in implementation of HACCP and ISO-9000 systems by the food industry and food control regulating agencies. Authorities in USA & EEC are promoting the use of these concepts. Quality control is the responsibility of the management to ensure that quality objectives are met, quality policies are implemented and documents are under control.

**WTO**

With the globalization and economic integration of nations, the trade and agriculture/ horticulture would be governed by new rules of the game. The concept of 'rule or run' would fully apply in every sphere of economic activity including agriculture after 2004 when WTO is fully operationalized and all the trade barriers are demolished. The post WTO phase would open the rooms for a sea of opportunity, as the same would also pose certain threats. With the free flow of trade, there would be global positioning of various countries determined by their core strength.

India wastes around 20-40 per cent of fruits which accounts for Rs. 6000 -7000 crores and it requires efficient use of technologies for post harvest management to save the losses. India wastes more fruits and vegetables annually than what UK consumes. This fact amply underscores the crucial importance of post harvest management in our country. The processed food industry is poised to be the largest industry in world over. While India consumes less than 5 per cent food in processed form, western countries consume more than 60 per cent. There are more profits in exporting value-added items than exporting fresh agro produce. To take the advantage of global trade opportunities in agro food items, India will have to grow internationally acceptable varieties and maintain quality edge. The preparation to grab the opportunities, and to face the WTO challages, India needs an integrated approach with support of government , research and industry which help farmers to improve farm productivity and produce quality, thus enabling the country to attain global competitiveness. The growth of the food processing industry will bring immense benfits to the economy of agriculturists, creating employement and raising the standard of large number of people through out the country especially in the rural areas.

# Resource conservation / management technologies in agriculture: Case of Jammu province.

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## ABSTRACT

Soil and water are the two prime natural resources on which life depends. Judicious conservation and management of these two resources are imperative for enhancement of agricultural production and its sustenance over several decades. In order to achieve the goal through "humps-free roads" of progress in quality and quantity of agricultural production, the *humps* need to be identified and eliminated. In other words, proper inventorisation of these resources is essential.

On 2.3% of world's land, our country supports 18% of world's population and about 16% of world's live stock, with only 4% of world's fresh water resources. However, as far as surface water resources are concerned, we have 7% of all the *utilizable flow* of *all river basins* in the world and thus three times luckier than the rest of the world. The state of J&K is still luckier, for, if the area illegally occupied by the neighbouring countries is excluded, the state possesses *more than twice* the proportion of surface water resources of land as that of rest of India.

The level of development of surface water resources for irrigation in this sensitive border state has been encouraging, particularly under the constraints of terrain conditions, inadequate power generation/supply and other restrictions imposed like Indus Water Treaty ( 1960 ). In addition, the Low-Altitude Sub-Tropical Plains of Jammu province possess a vast potential for agricultural production by virtue of ideal climate for *round-the-year* cropping, rich natural biodiversity and rich soil endowments. They also house the two major irrigation projects of Ranbir Canal (CCA=38,623 ha) and Ravi-Tawi Canal System

(CCA = 32,485 ha) accounting for 71% of net irrigated area of the province. The gross cropped area of the province is 61% of that of the state. However, notwithstanding all these strengths, the crop production and productivity levels of the region are not at all comparable to other neighbouring states/regions with similar natural endowments.

This paper envisages to highlight the constraints for enhancing agricultural production and productivity, judicious utilization of the created irrigation potential in different sectors, opportunities for optimal utilization of *available land and water resources* for achieving a break through in overall agricultural production and productivity, in the light of encouraging results from *on-farm water management research* endeavors in command areas conducted since 1990. It also attempts to prioritize the future thrust research areas in resource conservation/management including diversification of crops and cropping systems by tapping the vast potential for sub-tropical fruits, vegetables, medicinal/aromatic plants, condiments, spices, floriculture etc. which exist in the region.

**Introduction**

*Jala sçkçna vardhantç tharavõ naashma sanchayaah*
*Bhavyõ hi gunamaapnothi kriyaam praapya tathaa vidhaam.*

This ancient Sanskrit saying sums up the vital role of water as a tool for value addition to agricultural produce, the main theme of this symposium.

Soil and Water are the two prime natural resources on which the entire life on the globe depends. They are the two national assets of any nation and their judicious conservation and management form a decisive index of the "status of development" of the nation.

Over several centuries, our forefathers have succeeded in bringing 140 m ha of Indian land from natural ecosystem to agriculture. Since independence, we have added another 23 m ha to the net sown area, bringing 51% of our geographical area under the plough. This is more than 10% of the actual cultivated area of the whole world, supporting 18% of world's population and 16% of livestock, but with only 4% of world's fresh water resources. However, we are committed to raise food production from the current level of about 200 MT to 300 MT by the year 2020, from the same or *reduced* area. The state of Jammu & Kashmir, with its four main agro-climatic divisions, rich soil and diverse natural resources, special horticultural and other crops, has a unique place in the agricultural map of India. In order to fall in line with the national level endeavours at achieving a Second Agricultural revolution, it is about time that the state must set a reasonable target for agricultural production by 2020 and work towards achieving that goal. Jammu province, having three of the four agro-climatic divisions of the state and relatively higher production potential for agricultural crops, has an equally higher responsibility to contribute towards achieving the set target. This paper attempts to make broad inventorization of the natural resources of Jammu region as well as analyse the strengths and weaknesses in the current pattern of utilization and management of available resources so as to optimize them for enhanced agricultural production and productivity through fine-tuning of the available technologies.

## Soil Resources

The total geographical area of the state of Jammu & Kashmir is 22.224 m ha, but 54.4% of the area is under illegal occupation of neighbouring countries. Thus, 10.139 m ha of land under our control supports a population of about 110 lakhs. Out of this, the total reporting area is only 2.416 m ha and 74.3% of it (1.794 m ha) lies in Jammu Province. (Table1). If the net sown area of the state is 7,48,000 ha, 52% of it ( 3,90,000 ha ) lies in the six districts of Jammu province. The overall cropping intensity of the province is 175%. Moreover, the Low Altitude Sub-tropical Plains of the province possess a vast potential for agricultural production by virtue of ideal climate for round-the-year cropping, rich natural biodiversity and rich soil endowments. They also house both the major irrigation projects of the state : Ranbir Canal on river Chenab and Ravi-Tawi Irrigation Complex together accounting for 73% of net irrigated area of the province. Also, the gross cropped area of Jammu province is 61% of that of the state. However, notwithstanding all these strengths, the crop production and productivity levels of the Jammu region (especially the low-altitude sub-tropical plains) are not at all comparable to those of other neighbouring states with similar natural endowments. Thus, it should be the endeavor of all farm scientists and development departments of the region to develop and test those technologies for conservation, efficient utilization and judicious management of the "limited" soil resources of the region for enhanced agricultural production and sustain them at the enhanced level for bringing 97,000 ha of culturable wasteland under the plough would be prohibitive. In other words, overall cropping intensity of the region should be raised from 175% to more than 200% and those of irrigated lands to at least 300%. After all, the best method of conservation of both the soil and water resources in cultivated lands is through maintaining a continuous crop cover.

## Water Resources

The level of development of ground water resources in the state is only 1.33% of the net available ground water resources for irrigation (0.376 M ha-m/yr), as compared to 94% in Punjab and 84% in Haryana (Table 2). This is mainly owing to the constraints of inhospitable terrain conditions and grossly inadequate power generation / supply. However, extent of development of surface water resources in the state has been encouraging,

TABLE - 1

## SALIENT AGRI. LAND - USE AND WATER RELEATED RESOURCES OF J&K (2001-01)

**TGA (Mha) 22.224** **(10.139, ON EXCLUSION OF AREA ILLEGALLY OCCUPIED)**

| | State | Jammu | Kashmir |
|---|---|---|---|
| Total Reporting Area (Mha) | **2.416** | **1.794(74.3%)** | 0.622 |
| Under Forest | 0.658 | 0.650 (98.8%) | 0.008 |
| Not available for cultivation | 0.582 | 0.456 (78.4%) | 0.126 |
| Under Misc. trees | 0.072 | 0.062 (86.1%) | 0.010 |
| Culturable Wasteland | **0.140** | **0.097 (69.3%)** | 0.043 |
| Fallows | ·0.090 | 0.061 (61.8%) | 0.029 |
| Net Area Sown | **0.748** | **0.390 (52.1%)** | 0.358 |
| Gross Area Sown | **1.115** | **0.682 (61.2%)** | 0.433 |
| Cropping Intensity | 149% | **175%** | 121% |
| Net irrigated area (ha) | 310,870 | **100,800** | 210,070 |
| Gross irrigated area (ha) | 449,000 | **171,000** | 278,000 |
| % gross irrigated/sown area | 40.27% | **25.07%** | 64.20% |

(Source : Digest of statistics 200-01, Dte. of Economic & Statistics, Planning & Dev. Deptt., GOJK)

TABLE - 2

DEVELOPMENT OF GROUND WATER RESOURCES

| | Total replenishable GWR M.ha-m/yr | Net available GWR for irrigation M.ha/m/yr. | Net draft M/ha-m/yr | Level of GW Development % |
|---|---|---|---|---|
| Punjab | 1.865 | 1.679 | 1.576 | 93.86 |
| Haryana | 0.853 | 0.725 | 0.608 | 83.86 |
| Timal Nadu | 2.639 | 2.243 | 1.356 | 60.45 |
| Rajasthan | 1.271 | 1.071 | 0.542 | 50.61 |
| Gujrat | 2.038 | 1.732 | 0.717 | 41.40 |
| Uttar Pardesh | 8.382 | 7.125 | 2.684 | 37.67 |
| Jammu & Kashmir | 0.442 | 0.376 | 0.005 | 01.33 |

notwithstanding the said constraints of terrain and power supply, further confounded by the restrictions imposed like the Indus Water Treaty ( 1960 ).

In terms of the available surface water resources, our nation is three times luckier than the rest of the world, having 7% of utilizable flows of all river basins in the world on 2.3% of its TGA. But J&K is still luckier as it possesses about twice the proportion of surface water resources to land as that of rest of India. Table 3 provides an overview of development of surface water resources in Jammu province. The total irrigation potential created in the region is about 60% of that created in the state. However, the percent gross irrigated/gross sown area of Jammu is only 25%, as compared to 64% of Kashmir province (Table1). This is because the gross sown area of Jammu province is about 158% of that of Kashmir province, while as the gross irrigated area of Jammu is only 61.5% of that of Kashmir. It is seen from table 3 that except in case of Ranbir Canal System, the utilization of the irrigation potential is only about half of that created. Here the "potential utilized" as claimed by the irrigation department refers only to the potential "delivered" (and water cess collected) rather than the actual water made available to individual farm units, during any given season. In other words, "potential utilized" does not reflect the status of actual on-farm utilization pattern of the supplied water, the actual availability conditions in different sections of the command unit, equitable water sharing within a given command unit and efficiency of water use based on crop water demand or otherwise.

Table 4 shows the crop-wise total area sown, area irrigated and average yields of major crops (rice, wheat, maize) during 1998-2001. While 78% of rice in Jammu province is irrigated, almost all of maize is rainfed and only 25% of land under wheat is irrigated. The balance of >20% rice lands include low lying waterlogged areas of tail ends of command which are not supplied with water, areas under farmers' own tube wells and wells etc. and hence very small area under rainfed rice in foot hills. Thus, by and large, low rice yields reflect poor and inefficient utilization of the huge irrigation potential created in major irrigation commands, owing to absence of effective water-sharing/optimal allocation mechanism, leading to over-drawals at advantageous locations of water courses (due to uncertainty of next availability of water) thereby depriving the tail-enders of their due share. More over, such indiscriminate over-drawals have been creating/expanding the menace of irrigation induced water-logging.

Under the MOWR-ICAR-SAU Collaborative project of On-Farm Water Management Research (OFWMR) in the command of a distributary on Tawi Lift Canal Scheme (1995-98), it was observed that farmers of 42% of the CCA at advantageous head reach locations consume about 70% of the discharge that enters the distributary head during Kharif season leaving only 30% of available discharge to the rest of 58% land. It was also successfully demonstrated for three Kharif seasons that resorting to judicious economic irrigation scheduling in rice ( 7cm irrigation in 8 day intervals during non-rainy period ) can save >50%

TABLE - 3

DEVELOPMENT OF SURFACE WATER RESOURCES
(JAMMU PROVINCE)

Potential Created / utilized upto 1995 - 96 (Source : I&FC Dept. Jammu)

| | CCA (ha) | Pot. Created (ha) | Pot. Utilised (ha) |
|---|---|---|---|
| Two Major Projects : | | | |
| Ranbir Canal(1905) on R. Chenab | 38623 | 67814 | 65458 |
| Ravi-Tawi Irrn. Complex (1978, 82 - 83, 84-85, 92-93) | 46355 | 52880 | 24997 |
| Seven Medium Projects | 31761* | 47648* | 27920* |
| Minor Sector | 33564` | 44083` | 24850` |

* At different stages of devpt., except Partap canal on R. Chenab.

` Low utilization of created potential - needs detailed investigation - Linked with power supply also.

## TABLE - 4

### CROPWISE TOTAL AREA SOWN, AREA IRRIGATED AND AVERAGE YIELDS OF MAJOR CROPS

| Crop | | Area Cropped (ha) (2000 - 01) | Area Irrigated (ha) (2000 - 01) | Average yield ($Kgha^{-1}$) 1998 - 99 | 1999 - 00 | 2000 - 01 |
|---|---|---|---|---|---|---|
| RICE | J | 107780 | 84000 | 1596 | 1327 | 1739 |
| | K | 136270 | 1362000 | 2613 | 1745 | 1672 |
| | State | 244,050 | 220,000 | 2,182 | 1,562 | 1,702 |
| MAIZE | J | 215380 | 2000 | 2125 | 2017 | 1967 |
| | K | 114830 | 30000 | 800 | 430 | 889 |
| | State | 330,210 | 32,000 | 1,709 | 1,485 | 1,592 |
| WHEAT | J | 275250 | 69000 | 1536 | 1791 | 521 |
| | K | 5710 | 5000 | 770 | 803 | 915 |
| | State | 280,960 | 74,000 | 1,518 | 1,767 | 529 |

(Source : Digest of statistics 2000-01, Dte. of Economics & Statistics, Planning & Devpt. Dept. GOJK) of water normally applied to rice by farmers, that too with rice yield advantages of the order of 15 to 20%. Precious irrigation water thus saved can be diverted to the remaining 50% of CCA which is not being supplied with irrigation water in Kharif season.[1,2] OFWMR studies on the nature and extent of irrigation-induced waterlogging at distributary command level and re-estimations of area waterlogged using interpolation techniques of GIS-ILWIS Environment show that almost 50% of irrigation command areas already stand seriously waterlogged in a span of two decades of non-judicious irrigation practices (Table 5) [2,3]. The only plausible solution for this problem is: equitable water-sharing /allocation by farmers themselves, managed through Water-Users Association / Pani Panchayats in the Participatory Irrigation Management mode, which is a success in many states.

The very low wheat yields during Rabi 2000-01 in Jammu (Table 4) are the mean of almost negligible yields from rainfed regions (75%) and low yields from irrigated areas (25%), when the season was characterized by a record low seasonal rainfall (88.6mm) in 27 years. Low wheat yields, even in irrigated areas, in the region are due to late sowing of wheat, as much as 6 to 8 weeks after harvest of rice crop (extending to end of December/first week of January) and blanket closure of canal system for depriving one essential irrigation at CRI stage of late sown wheat. Both the late-sowing practices and blanket closure of canal system are highly unjustified, as demonstrated by OFWMR studies. For example, as per Indus Water Treaty (1960), we are entitled to draw 600 cusecs of water during Rabi season from river Chenab. But, through blanket closure of Ranbir Canal system for three months, a colossal amount of 132 million $m^3$ of water - our rightful share – equivalent to the total irrigation requirement of 53,000 ha of wheat crop - is let into Pakistan every year!! If we resort to a practicable system of "Phased – closure" of canal system for desiltation/repairs, at least 50% of this water can effectively be utilized to produce additional wheat crop worth Rs. 100 crores as well as to recharge the lower Kandi belt of Shivaliks for introduction of a number of horticultural crops. Only a bold and judicious policy decision in this regard can make such ambitious plans a reality and bring about a break through in optimal utilization of the "available water resources" of Chenab. More over, there are novel and generous funding provisions of Min. of water Resources, Govt. of India, enabling farmers to affect annual maintenance of water courses through water cooperatives with their own labour, at their own convenience, relieving the irrigation department of the cost and effort of desiltation and repairs of water courses in distributary commands and thereby reducing the period of canal closure for repairs of only the main canal to above 3 – 4 weeks. Many states have taken advantage of it. There is no reason why farmers of J&K should not avail of the opportunity[1].

TABLE - 5

STATUS OF WATER LOGGING IN THE COMMAND OF DISTRIBUTARY No. 3 ON TAWI LIFT CANAL SCHEME
1997 - 1999

Gross Command ARea = 599 ha

Culturable Command Area = 550 ha

| S.No. | Date | Area estimated by Conventional method of monitoring water table level (ha) | | | Area re-estimated by GIS technique (ha) | | |
|---|---|---|---|---|---|---|---|
| | | Waterlogged | Nearly waterlogged | Safe | Waterlogged | Nearly waterlogged | Safe |
| 1. | 10 Nov 97 | 224.4 | 31.4 | 6.3 | 554.7 | 44.3 | 0.0 |
| 2. | 6 Mar 98 | 196.2 | 34.5 | 9.4 | 466.3 | 132.7 | 0.0 |
| 3. | 18 May 98 | 139.6 | 72.2 | 18.8 | 233.1 | 365.9 | 0.0 |
| 4. | 20 Nov 98 | 183.6 | 22.0 | 12.6 | 508.5 | 90.5 | 0.0 |
| 5. | 12 Mar 99 | 83.1 | 84.8 | 47.1 | 104.0 | 495.0 | 0.0 |
| 6. | 21 May 99 | 105.1 | 78.5 | 31.4 | 264.8 | 334.2 | 0.0 |
| 7. | 19 Nov 99 | 149.1 | 18.8 | 22.0 | 403.5 | 195.5 | 0.0 |

## Integrated Watershed Development

As already discussed, 5,11,000 ha or 75% of the gross sown area of Jammu province is rainfed. In order to enhance the agricultural production and productivity of these lands, concerted efforts towards efficient in-situ rain-water conservation and utilization for increasing cropping intensity through modifications/diversifications of crops and cropping systems as well as rain- water harvesting and judicious utilization for introduction of agri-horticultural systems, with integrated watershed management approach involving active participation of beneficiaries in both physical and biological interventions are necessary. The current endeavors in this direction have been sparse, isolated, peripheral and without any impact, (as they are being handled by various departments and organizations), although some vital research-based knowledge has been obtained through IWDP and NWDPRA programs ( implemented by Forest and Agriculture Depts. respectively ) over the past decade. However, there is enough research information collected and documented as well as experience gained in perfecting the appropriate watershed management technologies for various agro-climatic situations in the country. Thus, the need of the hour is to consolidate the gains of such knowledge and translate them into planned implementation in the form of extrapolative/adaptive research/demonstration trials in selected micro-watersheds, with active participation of the beneficiaries in imposing the selected interventions. But, a detailed inventorization of the basic features, natural resources, economic and manpower status and potentials for development in specific areas of the watershed form a pre-requisite. In this direction, use of remote sensing tools and techniques can be very handy in quick and cost effective assessment of crop intensification potentials of different hydrologic landscape units of the watersheds. For example, within a period of 30 minutes, the crop intensification potential of different land units of (the section) of a watershed covering 4000 to 6000 ha can be assessed, by micro-relief analysis of a pair of aerial photomosaics, using a photogrammetric instrument with tracing attachment like Planitop-[4]. Such techniques, clubbed with the latest techniques of participatory rapid rural appraisal would lead to identification and prioritization of the right interventions needed for judicious development and management of specific watersheds.

Table 6 summarizes the current level of production of fruits in Jammu province as well as the additional potential area identified for introduction of sub-tropical and temperate fruits, by the Dept. of Horticulture. Similarly, Table 7 indicates the area and production of vegetables in the region as well as the annual deficit. In addition, the region possesses a vast potential for expansion of area and systematic improvement in productivity of barley, millets, condiments, spices and aromatic/medicinal plants in Doda district, bajra, oilseeds and floricultural crops in Jammu and Kathua districts, vegetable crops in Jammu and Udhampur districts and fodder crops in the entire province. If the ambitious plans of both the departments of agriculture and horticulture for expansion of their production programs with the future thrust areas already identified for the 10$^{th}$ FYP are to be realized, resource

TABLE - 6

**AREA AND PRODUCTION OF FRUITS IN J&K, 2001 - 02**
**(Source : Dept. of Horticulture, GOJK)**

| | Area (ha) | | | Production (tonnes) | | |
|---|---|---|---|---|---|---|
| | Fresh Fruits | Dry Fruits | Total | Fresh Fruits | Dry Fruits | Total |
| Jammu * | 49412 + | 27185 | 76597* | 62599+ | 17117 | 79716 |
| Kashmir | 92813+ | 52179 | 144992 | 938288+ | 79204 | 1017492 |
| State | | | 221589 | | | 1097208 |

*Additinal potential area identified in Jammu Province : 60,000 ha under Sub-tropical fruits & 70,000 ha under temperate fruits.

TABLE 7

AREA AND PRODUCTION OF VEGETABLES IN JAMMU PROVINCE, 1999 - 2002

(Source : Dept. of Agri, Jammu Div.)

| | Area (ha) | Production (Tonnes) | Productivity (t/ha) | Qty. Imported (tonnes) |
|---|---|---|---|---|
| 1999 - 2000 | 22000 | 280000 | 12.72 | 97340 |
| 2000 - 2001 | 22990 | 257000 (drought) | 11.17 | 187289 |
| 2001 - 2002 | 24000 | 312000 | 13.00 | ------- |

Per capita daily requirement = 350g (WHO)

Per capita daily consumption = 240g (National Ave.) : 102g (State Ave.) ; 156g (Jammu Div.)

For 45 lakh population of Jammu Div., annual deficit is about 2.75 lakh tonnes.

conservation, judicious utilization and management technologies have to be refined and sometimes re-defined with the watershed development/management approach, as most of the said crops are conventionally rainfed.

There is another important area of resource conservation/management, which is the use of secondary and tertiary sources of water for irrigation, i.e., waters of perennial drains, water courses/nallahs, many of which may contain industrial effluents and/or municipal wastes. These non-conventional sources of water, besides augmenting the limited water resources, **are reservoirs of plant nutrients.** However, caution has to be exercised to treat these waters before use, lest there could be harmful heavy metal concentrations, especially in industrial effluents [5]. Thus, quality of irrigation water from non-conventional sources and its impact on long-term production potential of the land as well as on pollution of ground water and consequently on human health should form one of the main researchable issues for future, as the demand for use of such waters is sure to rise.

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# Role of conventional and frontier technologies in sustainable management of vegetable, spices and condiments in J&K

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**Background**

India is the second largest producer of vegetables after China and traditional home for spices & condiments . It produced 98.50 million tonnes of vegetables from an area of 6.24 million ha during 2000-2001 ( table1) against 48.9 million tonnes from an area of 4.12 million ha during 1987-88 witnessing 6.7% increase in area and 20.1% in production during the same period. Among agricultural exports, fruits & vegetables constituted 4.1% ( during 2001-02) while processed fruits and vegetables 2.0% & spices 5.9% . Among vegegtables, fresh onions / vegetables; processed vegetables and seeds were the main components of export. Area under vegetables in J&K, increased from 15.5 thousand ha during 1987-88 to 41.2 thousand ha during 1988-99 witnessing 2.65 times or 26.5% increase in area, whereas production increased from 107.3 thousand tonnes to 606.9 thousand tonnes witnessing 564.4% increase during same period.

However, vegetable productivity increased from 6.9(MT/ha) during 1987-88 to 14.7 (MT/ha) during 1998-99 in J&K against corresponding increase of productivity from 11.9(MT/ha) during 1987-88 to 14.9 (MT/ha) during 1998-99 at national level . The increase in area and production clearly indicates the potential of growing vegetables in the region. Despite increase in area and production during past one decade, total area under vegetables constitute just 1% of total cropped area against 2.8% of area at national level.

The present requirement is around 100 million tonnes against estimated requirement of 224 million tonnes by 2020. It is further estimated that India shall have to increase production by over 50 per cent in potato and around 120% in vegetables by 2030 to meet the demand of ever increasing population in terms of food and nutrition security. Therefore, productivity per unit area has to be increased to combat the problem of food and nutrition security in country in general and this region in particular. The production figures often do not match with potential resources of the region; projected prospects of vegetable production ( including off- season vegetables, organic vegetables and seed production).

TABLE - I

# ESTIMATED AREA AND PRODUCTION OF VEGETABLE, SPICES AND FLOWERS IN INDIA

| Crop | 1997 - 98 | | 1998 - 99 | | 1999 - 2000 | | 2000 - 01 | |
|---|---|---|---|---|---|---|---|---|
| | Area | Production | Area | Production | Area | Production | Area | Production |
| Vegetables | 4.11 | 72.73 | 4.41 | 87.53 | 5.99 | 90.83 | 6.24 | 98.50 |
| Spices | N.A. | 2.76 | N.A. | 2.87 | N.A. | 2.91 | N.A. | 3.00 |
| Flowers | 0.07 | 0.37 | 0.07 | 0.42 | 0.09 | 0.52 | 0.10 | 0.55 |

Provisional Area = Million Hectares Production = Million Tonnes

Source : Economic Survey 2001 - 2002 (GOI)

**Some historical facts**

In paleolithic times ( more than 50,000 years ago) or early stone age man lived in caves and ate from wild . But in the later Paleolithic and Neolithic period (around 11,000 years ago), people knew how to make fire and learned to make better hunting implements by grinding stone. However, the cultivation of plants started about 9,000-11,000 years ago. Peas ,beans & cucurbits were probably the earliest cultivated plants during Neolithic period. It has now been accepted that agriculture as means of sustaining life began around 7,000 B C ( means 9000 years ago).

The oldest book Krishi -Parashara compiled in sanskrit by sage named Parashara in Ist century B C throws light into ancient Indian knowledge of farm practices and crop production. This book has now been translated by Nalini Sadhale in 1999. It is believed that original Krishi -Parashara was larger text. The version edited today emphasized importance of farming ,farmers and food production (verses 1- 10). It has also been mentioned that sages, philosphers and rich people have to beg for food.The Tamil poet Tiruvalluvar (125 AD ) has also expressed similar thoughts. Further, the emphasis on uniformity of seed during collection ( verse 159 ) clearly points to the existing knowledge that varietal characters are inherited . In Artha -Sastra of the 4th Century BC the technique of measuring rainfall has been described . It is interesting to note that distribution of unlimited rainfall pattern depicted in Aparanta (Konkan or coastal Maharashtra ) and hilly areas of north India , is relevant even today.

In 19th century BC , Gregor John Mendel ( 1865 ) based on his work on garden peas, concluded that certain unseen particles ( now called genes ) pass traits from generation to genertion. This work has laid the foundation of genetics as science and recognised GJ Mendel as father of genetics .In 20th century BC , the farmers in US for the first time purchased hybrid seed corn ( in 1922 ) resulting from cross breeding of corn plants.

In mid 20th century BC , double helical structure of DNA was discovered in 1953 and this has helped in understanding how cells in living things store , duplicate and pass genetic information from generation to generation .

In late 20th century BC , specific piece of DNA was transferred from one organism to another by Cohen and Boyer ( in 1973 ) that helped in improvement in agriculture. However, the first crops improved through biotechnology in 1990's were cotton, potatoes and soybeans. With rapid adoption of transgenic crops, area under transgenic crops have increased to 52.6 million hectares in 2001. The USA alone grew largest transgenic crop hectareage ( 68.0% ) in 2001 followed by Argentina , Canada and China . Now , the transgenics in cotton, tomato and brinjal are under field trials in India.

The J&K state does find place in historical treatise like *Nilamata Purama* (6th or 7th century AD) and Ksemendras Narmamala (11th - 12th century AD) . They have mentioned wide spread cultivation of vegetables viz Utpalaska, Kacchaguccha (mordern Kaodan) and Sanda (modern Hand or Lettuce) or Lettuce) in the Kashmir region. The mention of aramika or vegetable cultivation and irrigation and manuring of vegetable gardens is there in Rajatarangini. The vegetables like Kachidani and upal -hak served as food of poorer classes in ancient times. During Medieval period ( 1201 to 1846 AD) vegetables were grown but no systematic work was done on their improvement. The floating gardens were also quite common on city lakes in past and produced abundant crop of cucumber and melons. The watermelons cultivated on the floating gardens of Dal lake were so famous for their juice and taste that the same were taken to Agra by the emperors of the Mughals period.

**Agro -climatic zones**

The J&K State is fortunate enough to have a wide range of agro- climatic influences over its geographical area . The J&K state which actually spreads over to 2,22,236 sq kms, is practically confined to 1,01,387 sq kms (due to illegal occupation of territory by neighbouring countries and thus left with 45.50% of its total area ). The average height of the state , above mean sea level, varies from less than 300 metres to about 9400 metres . The following broad physical divisions are generally recognised.

***Low -altitude subtropical zone***

This constitutes parts of Jammu,Kathua,Udhampur,Poonch and Rajouri districts The mean height, above mean sea level, ranges from less than 300 metres to nearly 1350 metres. This zone is characterised by Monsoon concentration of precipitation; hot summers and relatively dry but pronounced winters , preponderance of alluvial soils.

***Mid to high-altitude Intermediate Zone (Sub-tropical-temperate transition)***

It encompasses all the areas above the outer-hill, including major parts of the districts of Poonch, Rajouri and Doda. Altitude ranges between more than 1350 metres above mean sea level more than 3000 metres . It is characterised by Monsoon concentration of precipitation; relatively wetter and colder winters and higher mean annual rainfall than subtropical zone .

***Mid to high- altitude, Temperate Zone***

The zone essentially covers the Valley of Kashmir, and small Inner Himalayan Valleys, comprising the districts of Pulwama, Srinagar, Anantnag Badgam Baramulla and Kupwara. The plain valleys have an altitude of about 1560 metres, which rises to 1950 metres in mid-belts and to 2400-3000 metres on the upper belts and altitudes then further rises to about 4200 metres in snow bound areas. It is charaterised by thewet and cold winters relatevely dry and moderately hot summer.

*Cold arid zone ( High altitude area of Inner Himalayas)*

The zone covers districts of Ladakh and Kargil in the East and Gilgit and adjacent areas in the North west zones. This is zone of highest average elevations. Dotted with deep gorges and desert plateous, the elevations range from more than 2400 metres to peaks ranging between 7200 metres to more than 8400 metres. Severely cold and dry winters and moderately hot and dry summers are special features besides preponderance of mountain meadow soils with appreciable spread of skeletal and tarai soils.

**Production/ improvement strategies**

In order to increase both vegetable production and productivity so as to meet nutritional and health security requirements of ever increasing population in the country and this region in particular , we need to increase production vertically from same or less area in near future. This invloves reorientation of our research priorities in years to come. Some of the areas which need immediate attention both from vegetables production and improvement point of view are briefly discussed as under :

***Sustainable production***

Sustainability is defined by the Technical Advisory Committee of CGIAR as "Sustainable agriculture should invlove successful management of resources for agriculture to satsify changing human needs while maintaining or enchancing the quality of environment and conserving natural resources". Accordingly, production of sustainable vegetables / spices involves efficient management of resources for meeting needs of ever increasing population while conserving natural resources and maintaining or enhancing quality of environment . Major components of sustainable vegetables/ spices production are (1) Increasing production for meeting needs of today and tomorrow, (2) Enhancing productivity and profitability (3) Judicial management of natural resources and other inputs ( including, fertilizers, irrigation and rainwater; and energy), and (4) Maintenance or enhancement of quality of environment.

***Nutrient management***

Balanced fertilization as per need of crop and capacity of soil for specific region; intergrated plant nutrient supply system (1PNS) which relates to combined applications organic and inorganic sources of plant nutrients ;use of green manures like summer legumes ( Sesbaina or mungbean residues) ; inclusion of legumes in cropping system; application of biofertilizers ( *Rhizobium, Azotobacter, Azospirillum* Blue -green algae (BGA), Azolla; PSB and VAM ) needs to be encouraged. Growing of mungbean in rainy season may contribute to the fertlilizer equivalent of 35-56 kgN/ha as urea in succeeding *rabi* crop. The contribution may increase to 75-94 kg N/ha as urea when its residuce is incorporated

### *Integrated disease & pest management ( IDPM)*

The continuous growing of one vegetable crop may lead to epidemics of plant pathogens or attack by most serious insect - specially in intensive cropping system. Intergrated disease & pest management ( which involves resistant cultivars, biological control, crop rotation, appropriate agronomic pratices and judicious use of pesticides / fungicides ) needs to be encouraged and adopted.

### *Efficient water management*

The soil moisture often influences the response to other inputs like plant nutrients. Input use efficiency is high when adequate soil moisture is there.

### *Crop diversification*

In predominant rice- wheat system in northen India, soybean could replace rice in upland well drained soils and rabi potato can substitute wheat crop so as to bring desirable change in existing cropping pattern towards improving productivity and soil health. The growing of a mungbean crop during summer and incorporation of its residue for green manuring could further improve productivity besides producing 0.5 tonnes /ha protein - rich pulse grain.

## Nursery and grafted seedings

The nursery of important vegetables like cauliflower, cabbage, knolkhol, broccoli, onion , tomato , brinjal, chilli/ bell pepper is currently raised through conventional means & poses many problems leading to low profitability . The severe yield losses are often reported in chilli/ bell pepper tomato, brinjal, etc due to prevalance of soil borne pathogens like *Fusarium, Pythium, Phytophthora, Rhizocotina, Sclerotinia etc* in all potential pockets.

The nusery raised under protected conditions ( low tunnels, polyhouse, green house, etc) is often superior to conventional/ open field nusery. The seedling can be raised earlier and under scientific manner for getting crop early in the season losses due to diseases & insect -pest are relatively less. We also need to have specialised implements for direct seedlings , planting and transplanting of vegetable crops in lower and higher hills. These implements need to be available at affordable costs and should be growers/ farmers friendly.

Grafted seedlings of watermelon, cucumber, melon and brinjal accounts for 57% & 70% production under open & green house condition in Japan where prevalence of soil brone diseases has necessitated this technique . The grafting can be done by cutting the cotyledon off & using the plug -in method . After grafting the seedlings are acclimatized by placing them on a moist sponge in a container and then promoted to adhere rapidly to the vascular bundles by placing them in a growth cabinet maintained at $20^0$ C temperature and 90 % for RH 6hr ( day-night) photoperiod adjustinf the light intensity to 7000 lux. The union of scion and stock completes in 2-3 days.

## Organic cultivation

Organic farming can play an important role in addressing problems of food, nutrition and health security; restoration of natural resources ( like land and water, etc) and boosting exports. The residual effects of pesticides are high. The fertilisers ( Urea, CAN, DAP, superphosphate, Phosphogypsum) have been found to contain toxins like lead, cadmium and radium 226 . These pesticidal residues and toxins can affect our food chains leading to many health problems. In view of the health hazards, now emphasis is being shifted to organic vegetables, spices and condiments by health conscious people. These products sell at premium prices in both domestic & overseas market. This calls for identification of hybrids/ varieties with acceptable quality in the international competition and standardisation of matching agro techniques for organic cultivation. The organic manures, biofertilizers, biopesticides, resistant/ tolerant varieties and specialized cultural techniques are important componets of organic agriculture and these need to be supplemented with the traditional organic farming practices prevalent in Western Himalayan region.

The available inputs (1) US organic food production Act 1990; (2) EEC Regulations on " Organic Agriculture 1991 (209 291); (3) The basic rules of 1FOAM;(4) The codex Alimentarinus" of FAOand (5) IFOAM-india standards can help in refining package and practices for meeting set organic standards acceptable at international level and for further certification & labelling by concerned agency. It could help in promotion of organic vegetables, spices and condiments for benefit of both producer and consumer.

## Off -season vegetable production

The important crops for off- season vegetable production in potential areas like Kud, Chenani, Basht (Udhampur) ; Ashar Baggar ( Doda); Thana Mandi ( Rajouri); Bani etc. in Jammu region are tomato, beans, bell pepper, cucumber, bitter gourd and leafy vegetables. These potential pockets supply vegetables in subtropical plains of north India when there is scarcity of vegetables in late summer and prices are very high in the market . Like wise temperate ( dry/wet) area of Kashmir valley and Ladakh can also serve potential source for offseason vegetable production for plains. No Systematic work has been done in the past on identifiation / development of suitable varieties/ hybrids for different agro-climates and their matching production technology or seed production aspects. These areas need immediate attention. There is further scope for exploring new areas in temperate region where winter crops can be grown in summer and produce can be supplied when these crops are not available in northern plains.

## Biodiversity

Biological diversity refers to the variety and variability among the living organisms and ecological complexes in which they occur. Diversity can be defined as number of different items and their levels ranging from complete ecosystems to the chemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecoystem, genes, and their relatives abundance. India is one of the 12 mega diversity countries of the world and harbours an estimated 5 lakhs out of 10-30 million species of living organism. The forests of penninsular India alone contain an estimated average of 4.09 species of seed plants per 1000sq. km and is next only to South Africa.

Biodiversity is common heritage of mankind and key for human survival . Biological diversity provides basic material for food security, poverty alleviation , cultural enrichment, health security and enhanced biological productivity of our planet. The use of plant diversity at a gene, genotype, and ecosystem level increases the capacity of crops to adjust against unpredictable weather conditions and unexpected pests and diseases and thus becomes important component of sustainable agriculture. Biodiversity is currently being lost at an unprecedented rate, thus threatening the sustainability of life support systems. It has been said that the loss of the world's genetic diversity would be worse than energy depletion, economic collapse, limited nuclear war, or conquest by a totalitarian govt. if such trend of loss of bio- diversity continues, then our descendants are least likely to forgive us.

North West Himalayan regions do contain tremendous agro - biodiversity especially in vegetables, spices & condiments. However, the diversity is being lost at alarming rate all over - though precise estimates are not available. A substantial portion of the bio-diversity may well have been lost even before it is completely documented . Impressive diversity exist in vegetable crops especially *Alliums*, cucurbits, solanaceous crops, cole crops, root crops and leafy vegetables in different agroclimatic regions( Gupta, 1996) . Among spices and condiments, ginger turmeric, chilli, saffron and Kalazira are important in J&K. Impressive diversity exist in ginger, turmeric, and chilli. Our group has collected and characterized genetic diversity of the region in ginger using morphological and proteins/ isozymes markers(table 2 ). Micropropagation protocal has been standardized in ginger and field demonstration has been successfully demonstrated (Fig. 1). There is need to work on low cost plantlet production using media maniplluations and use of natural light. The famous Kashmir saffron is in great demand for its quality and multiple uses but variability is limited in this crop in both Kashmir and Kishtwar region of Jammu. Micropropagation protocol has been standardised in this crop by RRL Jammu (CSIR). But more studies

## TABLE - 2

### PHENOTYPIC BANDING PATTERN OF DIFFERENT GINGER ACCESSIONS REPRESENTING SHIVALIK HILL RANGES

| Accession | Protein | Peroxidase | Esterase | Amylase |
|---|---|---|---|---|
| G/94/RK/Tg/01 | 11 | 11 | 6 | 6 |
| G/94/RK/B/02 | 12 | 11 | 6 | 4 |
| G/94/RK/Tk/03 | 11 | 5 | 2 | 5 |
| G/94/RK/M/05 | 12 | 13 | 7 | 6 |
| G/94/RK/D/06 | 12 | 7 | 2 | 5 |
| G/94/RK/Gb/07 | 12 | 12 | 7 | 5 |
| G/94/RK/P/08 | 10 | 12 | 7 | 5 |
| G/94/RK/C/10 | 12 | 11 | 6 | 6 |
| G/96/RK/Gh/12 | 12 | 11 | 2 | 5 |
| Bilaspur local | 13 | 11 | 7 | 6 |

Source : DBT Project Report

**STAGE - I**
**(Initation of cultures)**

Seed sterilization with $HgCl_2$ 0.1% (3-4m) and subsequent culture on basal MS medium.

↓

**STAGE - II**
**(Multiplication of shoots)**

Subculture explants (cotyledon/shoot tip/leaf) on MS medium +BAP (0.5 ppm) +NAA (0.5 ppm) subsequent subculture on same medium for multiple shoot formation.

↓

**STAGE - III**
**(Rooting)**

Rooting of micropropagated shoots on second subculture to basal MS medium

↓

**STAGE - IV**
**(Hardening)**

Prehardening under 1/2 strength MS medium under the indirect natural followed with acclimatization of plantlets after treatment with ABA 5 ppm or glycerol 0.7% or *Piriformospora indica / Trichoderma* (transferred to small pots with sterilized soil mix) under standard green house conditions with gradual increase in temp. and light intensity and reduction in humidity.

↓

**STAGE - V**
**(Field transfer)**

**Fig. 1 : Micropropagation protocol for tomato**

need to be taken up on field demonstration and low cost plantlet/ *in vitro* corm production for further commercialisation. Kalazira (*Bunium persicum* Boss) is another spice grown as wild in Kishtwar area of Jammu.

Agro-biodiversity both within and between species is best placed in traditional agricultural system. The conscious or unconscious efforts in past towards domestication, introduction , selection and exchange made by farming communities in the cultivated and semi cultivated crop species besides value addition to original bio resource, have resulted in overall diversity. The low-intensity agricultural practices (nomadic pastrols, traditional home gardens rotatinal fallow etc.) have helped in sustenance of many natural ecosystem. Modern agriculture, on the other hand encompasses more uniformity in terms of crop, variety and cultivation practises thereby discouraging maintenance of biodiversity. In remote and isolated areas in hill and mountainous regions, certain under utilized/ wild vegetables supplement food and nutritional security requirements besides ensuring diversification and value addition. Both *in situ* and *ex situ* conservation of plant genetic resources and their utilization in sustainable manner can address the needs of diversification under on-farm condition and food and nutrition security problem.

**Hybrid seed production**

Heterosis has been sucessfully demonstrated in vegetable crop like brinjal, tomato, okra, chilli, cauliflower and cucurbits (gourds, melons). Around 37 F1 hybrids in different vegetables crops have been identified in India through vegetable improvement programme. Now sizeable area is under these hybrids in different states especially Karnataka, Andhra Pardesh, Maharashtra and West Bengal. The hybrid seeds are very expensive and many farmers cannot afford them due to high cost and high requirements of inputs for successful cultivation.Hybrid seed productin is also cumbersome due to temperature extremes, damages from the rains; and attack of soil borne and viral diseases. The cost of seed can be reduced to greaater extent provided we make use of self incompatibility and male sterile lines in cole crops and solanaceous vegetables, respectively. Nearly 40% of the total labour expenditure in solanaceous vegetables is on emasculation process. For example, the genetic male sterlity is availeble in tomoto and can be exploited for hybrid seed production but maintenance of male sterile line is difficult and is cumbersome with conventional methods. We have developed micropropagation protocol for multiplication of male sterile lines in tomato and this protocol is reproducible and dependable(Fig.2). The male sterility has expressed in field grown tomato (male sterile plants). In chillies genetic male sterlity can be exploited. Two successful examples are CH1 and CH3 hubrids released from Public sector institutions where over 100% of heterosis is available. Hybrid seed production can also be taken up under protected conditions in areas where problem of temperature extremes and viral diseases prevail. The identificaltion

**STAGE - I**
**(Initiation of cultures)**

Shoot bud sterilization with Hg $Cl_2$ 0.1% (3-4m) and subsequent culture on MS medium + BAP (5ppm)+NAA (1ppm)

↓

**STAGE - II**
**(Multiplication of shoots)**

Subculture on MS Medium + BAP (2.5ppm) + NAA (1.5ppm)

↓

**STAGE - III**
**(Rooting)**

Shoot multiplication with rooting on second subculture to MS medium + BAP (2.5ppm) + NAA (1.5ppm)

↓

**STAGE - IV**
**(Hardening)**

Prehardening under 1/2 strength MS medium under the indirect natural followed with acclimatization of plantlets after (transferred to small pots with sterlized soil mix) under standard green house conditions with gradual increase in temp. and light intensity and reduction in humidity

↓

**STAGE - V**
**(Field transfer)**

Field transfer on soil beds treated with *Trichoderma* for production of mini rhizomes

**Fig. 2: Micropropagation protocol for ginger**

of parental lines for suitable hybrid combination and sustainable utlisation in hybrid seed production through blending of conventional and frontier technologies is need of hour and should be given priority in improvement programmes.

## Temperate seed production

Higher reaches in Udhamur, Doda, Kathua and Rajouri district in Jamu province and majority of temperate (wet/dry) areas of Kashmir valley and Ladakh can be exploited for seed production of temperate / European varieties of different vegetables like radish, carrot, turnip, cabbage and late cauliflower besides some exotic vegetables. It has now been possible to have production of seeds of knol khol and broccoli in lower altitudes in Jammu and Rajouri. The specific potential pockets with suitable micro-climates based on edaphic and environment factors need to be identified and seed production techniques need to be standardised. Further, the concept of seed village needs to be adopted for important varieties in that particular area. The streamlining of seed production in temperate areas will reduce our dependence on imports from abroad or from other temperate regions of the country.

## Producltivity in plains /hilly (dry / wet) areas

### *Open v/s protected cultivation*

Presently, focus at National level is on high cost green houses for export oriented units growing cutflowers, vegetables and other low volume high value crops. They can be useful for protection against rains, raising crops in hail prone areas and hardening of tissue culture raised plants. We have one such green house with us as we are using it for hardening of micropropagated plants. In serveral countries this technology is being used for production of wide range of vegetables and flowers. It may have limited applications in our country due to high cost involved in establishment and maintenance of such high tech green houses.

In cold arid areas of Ladakh, high productivity in vegetable crops hav e been observed at Leh (Gupta 1996. The yield as high as 1914 q $ha^{-1}$ cabbage, 1384 q $ha^{-1}$ in tomato and 729 q $ha^{-1}$ in cauliflower have been recorded (Table 1). Similar trend was observed in local radish and turnip. Further the low polyhouses or green houses and trench cultivation has been taken up successfully in this region. This concept needs to be spread up to other hill and mountaneous regions.

Green houses especially low cost poly houses have also become popular in high altitude areas. In cold arid areas of Ladakh the size of glass house is usually in multiples of 9 x 4.5 x 3m and that of poly house is 20 x 4.6 x 2.6m. The local design poly houses are usually made of unbaked mud bricks and willow wood. The usual size is 9.7 x 2.54 x

## TABLE - 5

### YIELD PERFORMANCE OF CABBAGE, CAULIFLOWER AND TOMATO AT LEH - LADAKH

| Cultivar | Yield Gross | Net | Av. head/curd wt.(g) | Cultivar | Yield (q ha$^{-1}$) |
|---|---|---|---|---|---|
| **Cabbage** | | | | **Tomato :** | |
| Yamuna | 1914 | 1245 | 2240 | IAHS Naveen | 1384 |
| Pride of India | 1649 | 1305 | 2350 | PED | 1205 |
| IAHS -2 | 1381 | 1153 | 2080 | S -12 | 935 |
| Golden Acre | 1851 | 1137 | 2050 | Pusa Gaurav | 902 |
| **Cauliflower :** | | | | IC-91-1 | 871 |
| IC - 206 | 673 | 417 | 750 | Arka Vikas | 565 |
| Silver King | 729 | 341 | 610 | Arka Saurabh | 406 |
| Snow Ball K-16 | 625 | 396 | 710 | Arka Ahuti | 184 |
| Snow Ball K-1 | 703 | 278 | 500 | Pusa Ruby | 536 |
| Snow Ball (H) | 538 | 364 | 980 | | |

Gupta et al. 1996

TABLE 4

CHARACTERISTICS OF SOILS OF DIFFERENT REGIONS IN LADAKH

| Soil Properties | Leh (3)[a] | Khaltisi (10) | Nubra (15) | Kargil (3) | Ladakh (31) |
|---|---|---|---|---|---|
| pH | 7.6-9.6[b] (8.2)[c] | 7.4-8.3 (7.8) | 7.4-10.0 (8.2) | 7.0-8.2 (7.8) | 7.0-10.0 (8.0) |
| Ec($dSm^{-1}$) | 0.09-0.96 (0.27) | 0.09-0.21 (0.14) | 0.06-1.50 (0.13) | 0.13-0.26 (0.17) | 0.09-1.50 (0.16) |
| O.C (%) | 0.03-0.91 (0.65) | 0.60-2.10 (1.24) | 0.11-2.22 (1.18) | 0.96-2.04 (1.42) | 0.03-2.22 (1.18) |
| O.M. (%) | 0.05-1.55 (1.12) | 1.03-3.62 (2.14) | 0.19-3.83 (2.05) | 1.66-3.52 (2.45) | 0.003-0.192 (2.05) |
| **Nurtients :** | | | | | |
| Total N(%) | 003-0.078 (0.056) | 0.52-0.181 (0.107) | 0.01-0.192 (0.103) | 0.083-0.176 (0.123) | 0.003-0.192 (0.103) |
| Available P (Kg $ha^{-1}$) | 2.3-22.5 (17.00) | 2.3-58.4 (22.10) | 2.3-78.9 (27.12) | 4.5-92.1 (36.70) | 2.3-92.1 (25.87) |
| Avialable K (Kg $ha^{-1}$) | 18.4-101.2 (48.3) | 9.2-66.7 (29.7) | 138.0-874.0 (332.0) | 18.4-89.7 (46.7) | 9.2-874.0 (166.2) |
| C:N ratio | 10.0-11.7 (11.6:1) | 11.5-11.6 (11.6:1) | 11.0-11.6 (11.5:1) | 11.6-11.6 (11.5:1) | 10.0-11.7 (11.5:1) |

a- No. of villages b- range c- Mean value

*Source : Personal Communication with Dr. Pardeep Wali*

0.9m. All these green houses face south and are covered by UV stablished polythene film. Trenches of 5ft. width and 3ft. depth are also useful for extending cropping season and growing leafy and other vegetables during winter when ambient temperature is below zero.

Leafy vegetables (including beetleaf, spincach, vegetable mustard, fenugreek, chinese cabbage, kale etc.) and herbs (including parsley, coriander and mint) are suitable for trench cultivation. The Capsicum / brinjal / okra / chilli and cucurbits which were not earlier possible can be grown in trenches during June - September . We can also raise off season potato and radish. The use of these structures for raising early nursery is common practice and it has now become possible to have round the year cultivation of vegetables.

Low plastic tunnels can also be used for raising seedlings during winter and protected cultivation. Low cost plant environment control structures such as shade /net house, low tunnels and plastic mulches / covers can be sucessfully adopted both in plains and hilly areas with varied degree of success.

***Organic vegetables (under protected conditions)***

The organic vegetables can also be grown under protected conditions. It is possible to grow palak, chinese cabbage, turnip, radish, knol-khol, beans, peas, summer squash and jerusalem artichoke with virtually no pesticides or inorganic fertilisers provided 15 tonnes of organic manure per hectare is used. Besides, the plastic mulch especially black polythene mulched crop gives higher yield and no weeding is required.

***True potato seeds***

These can also be produced in hilly and mountanious regions and also in subtropical plains by extending the photo period by 4-5 hours. The TPS are easy to store, transport and are free from tuber borne diseases and viruses. The TPS lines exhibiting low variability for maturity and tuber characteristics are being identified. This technology has been successful in Tripura and North Eastern region and can be extended to other areas where quality tubers can not be produced or transportation over long distance is expensive.

***Integrated water management (under cold arid conditions)***

The annual precipitation is very little in Ladakh region. Indus, Shayok, Suyru, Zanskar and other rivers and natural springs are main sources of irrigation in Ladakh. The villages are usually in foot hills of snow glaciers where snow melted water comes and is utilized as watershed . The canals are constructed by community for trapping snow melted water from glaciers which run through rocks sand and rough lands. The water is then directed to fields through sub-channels. The cooperative approach or community approach in construction and maintenance of irrigation canals, water tanks and harvesting of glacier water has proved effective in the past. This traditional system works well. However, the use of polythene mulching is also becoming important in incerasing production through reduced soil evaporation rates resulting in lowering the number of total irrigations and control of weeds. Wali (1996) while working on cabbage reported that all mulching materials *viz* white alkathene (WA) black alkathene (BA) newspaper (NP) and gunny bage (GB) were effective in improving yield attributing characters and yield as well in decreasing number of irrigations.

**Plant Biotechnology**

There is need to develop imporved varieties / hybrids / transgenics with higher yield, better quality and resistance to biotic and abiotic stresses by supplementing conventional breeding techniques with biotechnological tools (including molecular biology and genetic engineering). Attention is now being focused on development of transgenics having industrial , economic pharmaceutical, nutritional and environmental importance. Transgenics for insect resistance, fungal / viral resistance, improving shelf life/ quality are now reality in vegetable crops. The global area under transgenic crops is 52.6 million hectares (James 2003). During the past two decades, some of the areas where work has been done in vegetable / spices and condiments in the country are (1) Micropropagation 2) Embryo rescue and somatic hybridization 3) Somaclonal variation and *in vitro* selection (4) Secondary metabolites production (5) Molecular characterisation and (6) Transgenics.

Micropropagation for the multiplication of disease free planting material in important vegetatively propogated crops; maintenance of self incompatible and male sterile lines *in vitro* gremplasm conservation in vegetatively propogated crops have been successfully used. Reproducible and dependable micropropagation protocols have been developed for tomato and ginger (Figure 1 & 2).

Embryo rescue has been used transferring genes from wild or related species to cultivated backgrounds for resistance to biotic and abiotic stress with varied degree of success . Somatic hybridization has also been used for transferring genes from both nucleus and cytoplasm.

Transgencis have been developed for resistance to insects in brinjal and tomato in different labs in India. However, their field testing and biosafety aspects need to be studied. The other new areas relevant to vegetable crops are tolerance to drought, temperature extremes, fungi and viruses, improving shelf life and quality in different vegetables / spices and condiments. Production of vaccines through molecular farming has been successfully demonstrated at lab level in few vegetable crops. It is important to look into the biosafety aspects of these transgenics before they are released for general cultivation. Further, molecular approaches can be used for characterization of agro bio-diversity at generic species and genic level.

To sum up, enchancing productivity per unit area and per unit time through defending gains already made during the past in respect of vegetables, spices and condiments; spreading gains made earlier to new area and farming systems (especially in rained and

TABLE - 5

## GLOBAL AREA OF TRANSGENIC CROPS IN 2000 AND 2001 : BY COUNTRY (MILLION HECTARES)

| | 2000 | % | 2001 | % | +/- | % |
|---|---|---|---|---|---|---|
| USA | 30.3 | 68 | 35.7 | 68 | +5.4 | +18 |
| Argentina | 10.0 | 23 | 11.8 | 22 | +1.8 | +18 |
| Canada | 3.0 | 7 | 3.2 | 6 | +0.2 | +6 |
| China | 0.5 | 1 | 1.5 | 3 | +1.0 | +200 |
| South Africa | 0.2 | <1 | 0.2 | <1 | <0.1 | +33 |
| Australia | 0.2 | <1 | 0.2 | <1 | <0.1 | +37 |
| Mexico | <0.1 | <1 | <0.1 | <1 | <0.1 | - |
| Bulgaria | <0.1 | <1 | <0.1 | <1 | <0.1 | - |
| Uruguay | <0.1 | <1 | <0.1 | <1 | <0.1 | - |
| Romania | <0.1 | <1 | <0.1 | <1 | <0.1 | - |
| Spain | <0.1 | <1 | <0.1 | <1 | <0.1 | - |
| Indonesia | - | - | <0.1 | <1 | <0.1 | - |
| Germany | <0.1 | <1 | <0.1 | <1 | <0.1 | - |
| France | <0.1 | <1 | - | - | - | - |
| **Total** | **44.2** | **100** | **52.6** | **100** | **+8.4** | **+19%** |

*Source : James (2003)*

hill and mountanious regions); making new gains through diversification and value addition with effecient management of natural resources or other inputs and decreasing ill effects on environment; and judicial blending of conventional and frontier technologies, is key to sustainable production in the country in general and in this region in particular.

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# Impact of WTO on Livestock Industry

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Live stock forms an integral part of rural economy. The population of livestock during 1995 was 206 million cattle, 80 million buffaloes, 45 million sheep, 119 million goats and 435 million poultry. The contribution of livestock sector to agriculture GDP has increased from 17 to 29 per cent. Livestock sector provides regular employment to 18.4 million people constituting 5 per cent of total work force. The small, marginal and landless farmers's dependence on agriculture put them under pressure due to vagaries of monsoon which leads to uncertainty of income, which can be partly alleviated by maintaining livestock.

The livestock production has come a long way in India in the last five decades. The post independence period has been characterised by the planned development of the national economy. The major improvement has been in milk production which increased from 17.4 million tonnes in 1951 to 74 million tonnes in 2000 and attained the status of largest milk producer in the world by pushing USA to second position. The per capita availability of milk increased from 105 g to 209 g per day during the above said period.

The uniqueness of Indian livestock sector is 'production by masses' as compared to 'mass production' by a few in developed countries and this is important while deciding policy approaches in economic liberlization programme. A large number of livestock farmers need to be retained and sustained in livestock sector as no alternative is possible for their livelihood. World Trade Organisation (WTO) could bring benefits to Indian livestock sector provided that Indian interests are defended well at the negotiations or else the domestic animal products sector may face severe competition with imported products and the farmers could lose their livelihood altogether.

The mandate of W T O covers trade in goods, trade-related investment measure and trade related intellectual property rights. W T O is committed to establish an open and liberal global environment free from any barriers or restriction encouraging participation of both developed and developing countries.

Among several W T O agreements, those that are relevant to agricultural products including livestock sector, dairying and animal products are:

* Agreement on Agriculture (AOA)
* Sanitary and Phytosanitary (SPS) Agreement
* Technical Barriers to Trade (TBT) Agreement
* The AOA covers 3 areas i.e. (i) Market Access, (ii) Export subsidies and (iii) Domestic support.

***Domestic support measure:***

Amber box measure or aggregate measures of support (AMS) include market price support, non-exempt of direct payments and other subsidies not exempted from reduction commitments. Among the countries heavily subsidizing their agriculture the developed countries were required to reduce the total AMS by 20% over 6 year (retaining 80% of subsidies) and the developing countries by 13.3% over 10 years.

Blue box measure are exempted from any reduction and include production limiting measures such as livestock production payments based on a fixed number of heads, payments based on fixed areas and yields.

Green box measures which are also exempt from reduction commitment include government expenditure on research, pest disease control, training, extension and advisory services, inspection service,marketing service and infrastructure services and government assistance to private storage of products as part of food safety programme.

**Opportunities for Indian Dairy Industry:**

The international price for SMP during 1992 ranged between US $ 1500-2000 per metric ton. The price remained depressed during 1993 with minimum export price as US $ 1,250 per metric ton. These prices were not attractive and likely to improve. A brief account of opportunities for India's export is presented below.

**Cheese:**

The cheese industry in India is in the stage of infancy. We do not produce varieties of cheese needed in the international market. Therefore, in the short term the export opportunities are limited. Since the major impact of GATT would be on price and demand of cheese, the advantage is likely to be taken by countries like New Zealand and Australia.

Indian dairy industry will have to upgrade its technology for manufacture of cheese, if it wants to capture world market.

**Butter**

As a result of opening of minimum import access, New Zealand and Australia would get access to EEC market leaving their present market for other exporter. There would also be increase in international price of butter. India can take advantage of the situation and export butter to near East and South East countries.

**Milk powder**

Approximately 3 million tonnes of milk powder are traded in the world market out of which SMP accounts for about 1 million tonnes. The major importers are South America, South East Asia and Africa. Some of these countries are more sensitive to upward movement of world market price and their often fragile economics make it difficult to understand commercial import. An increase in the international price of SMP is, however, anticipated and India can develop the export, market, similarly export of WMP from EEC are likely to be seriously affected as a result of GATT.

**Meat and meat production sub-sector**

The production of meat in India is estimated as 3.377 million tonnes to which buffalow meat is an important contributor accounting for about 35% of total meat production. Buffalo meat is a by-product of buffalo farming maintained mainly for milk production. Meat from sheep and goat form the main source of meat for domestic market, their contribution to total production being estimated at 18.45% meat production in India for domestic consumption is still traditional. Most slaughter houses are situated mere consumption center where animals are brought from the rural areas either on hooves or transported in trucks. Meat is marketed hot and fresh. Only recently in few metropolitans, chilled/frozen meat is sold under a brand name. However, the meat export trade has been modernized. A large number of meat processing plants have been set up in Mumbai, Delhi and other port towns for exports.

Exports from India: During 1992-93 meat and meat products valued at Rs. 230.79 crore during 1991-92 thereby registering an increase of 11.4 % in value terms. During April-September 1993 the value of export of meat was Rs.156.51 crore as against Rs. 111.33 crore during the corresponding period of the previous year showing an increase of 40.6%. The meat export during 1993-94 was valued at 347.5 crore. Buffalo meat constituted over 75% of the export in terms of value. The meat export in 1999-2000 was Rs. 781 crore.

**Opportunities of India**

The export of meat from EEC is highly subsidised, which keeps the international price of beef depressed with reduction of production and export subsidies, the international price of beef is going to increase. This will lead to cut down in imports from EEC. The strength of India lies in buffalo meat which at present is imported by developing countries as a cheaper substitute for beef. Buffalo meat offers a great potential in case a programme of raising and fettering of buffalo male calves is taken up in rural areas. Many countries have banned import of meat from India due to diseases like rinderpest and foot and mouth. Creation of diseases free zone would remove this constraint. It would also require creation of an infrastructure of setting up of modern abattoirs, cold storages, refrigerators, transports and containers. In study done by Indian Institute of Foreign Trade on export potential of Indian meat, the potential exports were projected at Rs. 1000 crore per annum by end of 1990's provided the suggested infrastructure was created and production systems followed. It has not been possible to develop exports to the projected level due to structural and institutional weakness. It rose to Rs. 772 crore by 1998-99. By 1999-2000 the exports were valued at Rs. 781 crore.

**Poultry sub-sector**

The production of poultry eggs and meat has shown a tremendous growth in the last three decades. During 1995 the estimated production of eggs was 33000 millions and population of broilers was 330 million. More than 50% of eggs and broilers come from four states namely Andhra Pradesh, Maharashtra, Punjab and Tamil Nadu. With the signing of GATT India holds excellent prospects in the international poultry trade, as the cost of production of eggs is lower than the developed nations. The trend in the international industry has to make a timely entry into this area. Collaborations with fast food joints would give great momentum to the production of broilers. The poultry industry has so far been concentrating on meeting the domestic requirement and exports have not been its priority. India's share in the world market is just 0.2% in case of eggs and negligible in case of chicken meat and processed products.

The world trade of eggs in shell during 1992 was 0.8 million tonnes valued at $ 990 million. The major importing countries were Algeria, Iraq, Kuwait, Oman, Saudi Arabia and UAE and the imports were mainly from the EEC countries. In the Far East the major importers are Hong Kong and Singapore who import from China and Thailand. During 1992-93 India exported 117 tonnes of eggs in shell valued at Rs. 106.3 millions. It is felt that the export of eggs offer opportunities for India especially to the Near East markets.

**Leather sector**

Leather has been identified to be an opportunity sector for India. The rawhides and skins wealth and human capital of the country make India resource rich for leather sector. Technology base for leather industry is also a developed one. Leather sector has been one of the industries of the country which has been initiated into early globalization. Main implication of trade liberalization under WTO will be progressive reduction of import duties on raw materials, components, consumables etc. when import duty on inputs needed by the leather based industries is progressively reduced it will improve the competitiveness of the domestic manufactures of leather products. This will help us to increase our share in global market. Indian leather earnings were Rs. 9000 crores in 2001-02, which is 3.2 % of the global trade against 10% of raw material base. Global trade share target for 2010 is estimated at 10%.

**Advantages of Indian livestock sector**

* Lower production costs of livestock products.
* Lower labour costs and livestock sector is labour intensive.
* Negligible subsidies in the pre-WTO period, which facilitate trade competition.
* Large bio-diversity and natural technologies.
* Rich in traditional practice and technologies.
* Absence of diseases such as BSE (mad cow disease).
* A large scope for increasing livestock productivity and efficiently.
* Proximity to livestock products importing countries.

**Disadvantages to Indian livestock sector**

* Livestock production in developed countries receives considerable subsidies which even after WTO adoption would remain substantial to effectively compete with India.
* In the area of sanitary and phytosanitary measure, developed countries have adequate infrastructure to take advantage and put India in defense
* Developed countries have sound statistics in livestock sector and could make precise estimate for initiating appropriate actions/programmes.
* Smaller number of units with large production facilities of developed countries, have cost and quality benefits and adopt easily technological advances.
* Social and religious objections in India may affect adoption of programmes based on scientific and technical merit.
* Unequal trade bargain.
* Large disease and residue monitoring costs in view of large livestock populations.

In India there exist a large domestic market for most of the livestock products. Further, the prevailing prices are generally higher than international prices. The industry, therefore, had hardly any incentive to export. The competitiveness of production in India is likely to improve further under GATT provisions. The basic constraints are poor genetic potential of animals though good at endurance, disease resistance, the production performance.

Some problems addressed to develop exports are :

a) **Consistency:** In the past we have not been following a consistent export policy. There is tendency to show spurt in the market price when a commodity is allowed to export.

b) **Quality:** Most livestock product being food product that requires strict quality control in production and processing. In case of dairy product it would not be enough to upgrade quality control in processing plants but quality of milk at the stage of production and collection will also require improvement.

c) **Infrastructure bottleneck:** Up-gradation of internal transport, port, air cargo and refrigerated storage facilities would be required.

d) **Technology:** Technology, brand image, marketing and distribution channel up-gradation would be required to develop export. Working out collaboration with multi national may be necessary in the wake of growing intra-industry and intra-firm trade.

e) **Production:** We have not been producing for the purpose of exports. Our tendency has been to export surplus to domestic requirement. In case of livestock products short and medium term prospects of exports of meat and poultry eggs to mob up surplus production. Unless production is sufficiently elastic, higher exports would mean rise in domestic price. The solution to the problem lies in taking up export production in designated areas.

So it can be said that globalization of Indian agriculture would provide opportunity for export of livestock products especially dairy products, meat and poultry eggs. This would, however, require an action plan to produce commodities at internationally accepted quality standards.

# RECOMMENDATIONS OF THE SYMPOSIUM

To meet the challenges to Indian agricultural in the context of WTO, the following recommendations emerged:

* Reduction in production costs, improvement in quality of agricultural produce and improvement in storage facilities, infrastructure need priority attention.

* Systematic research on molecular/biotechnological approaches in the preharvest improvement in the quality of grain proteins in cereals needs to be strengthened. The ultimate scientific goal in this direction is to meet cereal chickpea combination with respect to starch and protein in cereal grains.

* Sustainability of agricultural production based on water resources, soil fertility, disease resistance, enviornmental variations and social aspects in terms of employment generation must be ensured.

* Location-specific land use system of Western Himalayas must taken into account quality and size of land holding, degrading soil fertility, low soil temperature, high rainfall and soil erosion. In this regard, the possibility of intensifying production of off season vegetables, floriculture, medicinal/aromatic plants and livestock production needs to be exploited.

* Propagation protocols for walnut and *Morchella* sp(Guchi) must be developed for J&K region where their production potentialities are very bright.

For production technology in rainfed and hilly areas, the core strategies to be followed are as follows:

* Off season tillage, ploughing across the slope, timely planting, *in-situ* moisture conservation, selection of suitable crops and varieties matching with growing season, proper plant population, timely weed control, balanced fertilizer use, need based plant protection and rain water harvesting and its recycling are required.

* Food fuel, fibre, fruit, milk, etc. should be produced on water shed basis to avoid over exploitation of natural resources. Water conservation and control of floods is to be given due attention. This would help in recharging of ground water, employment generation, reduction in droughts and siltation in rivers.

*    The cropping systems should be diversified by land uses in agri-horticulture, agri-silviculture, silvipasture and raising of medicinal aromatic and dye-yielding plants.

*    Rain-fed areas, not suited for crop production, should be developed as pasture and grazing lands for live stock production. This will certainly help in raising the economic status of the farmer.

*    Farm machinery like seed-cum-fertilizer drill, which help in timely sowing and fertilizer placement, need to be popularized.

*    The contingent plans for aberrant weather conditions need to be developed well in advance and also some policy issues, like improvement in credit availability, extension of crop insurance schemes to rain-fed crops and suitable strategies for voluntary participation of the farmers in the water-shed development, need to be taken.

For tree nut improvement for sustainable production in hilly and rain-fed areas of Kashmir valley, the following recommendations emerged:

Old orchards should be rejuvenated. supply of quality plant material should be strengthened. Production and protection technology need to be enhanced. The cultivation of four varieties of almonds, namely **Makhdoom, Parbat, Waris** and **Shalimar** and two varieties of walnut, namely **Hamdan** and **Sulaiman,** released by SKUAST-K, would lead to (i) imparting varietal status to tree nut industry currently based on heterogeneous and non-descript trees of seedling origin, (ii) stable production of globally competitive uniform produce amenable to sorting, grading and processing, and (iii) better use of shrinking land and other resources by way of higher productivity, cropping efficiency, profitability and sustainability associated with such varieties.

For production technology of temperate fruit crops in rain-fed hilly areas of north-west Himalayas, the strategies which need to be adopted are: (i) selection of fruit crops, (ii) orchard planting technology, (iii) plant raising technology, (iv) collection of run-off water, (v) moisture conservation, (vi) organic farming, (vii) crop regulation through chemicals and (viii) watershed management. Stress is to be laid on the development and production of Pistachio nut, propagation of nuts, *in situ* moisture conservation, collection of run-off water through crescent bunds, with open catchments, moisture conservation with the use of black polythene and dry glass mulches, crop regulation by applying nutrients at pre-glooming, use of drought-tolerant root stock, improvement in production technology, efficient market system and establishment of agri-production zones in view of the implementation of WTO regime.

Pertaining to the scenario in development and acceptability of transgenic crops, following points of recommendations emerged:

* Benefits should be derived from the advancement in transgenic in insect/pest resistance, reduction in post-harvest losses and development of value-added food products with special reference to improving quantity and quality of oils, proteins and vitamins.

* Development of golden rice containing â-carotene (a precursor of vitamin A) is a potential achievement in checking the partial blindness in children.

* Anti-bacterial proteins from *Bombyx mori* has wide application in pharmaceutical and food and feed preservation.

* By the year2004, both process and product patents are likely to be allowed in India.

* Since the field of genetic engineering and bio-technology is a costly affair, so a joint approach for development of transgenic amongst agricultural and traditional universities should be followed. There should be good synergism between traditional universities, involved in more basic research, and agricultural universities, doing more applied research, so that the harvest of bio-technology becomes fruitful in the near future.

On the processing of farm produce and value addition under changing marketing scenario, the following points of recommendations emerged:

* Production and productivity per unit area in cereals, oil seeds, fruits, vegetables and spices need to be increased so as to feed the ever-increasing population in years to come.

* The research and development should give emphasis on pre-harvest management, primary processing, diversified use of products/bi-products and creation of new markets.

* The cost of production needs to be reduced with improved quality of the farm produce for catering to the need of both domestic and international market.

* Infrastructure provision for proper storage, transportation under desired conditions, packing of farm produce needs immediate attention.

* Sustainable production through judicial management of natural resources and value addition should be given priority in the future programme. Also, on-farm value addition through cheap technologies is needed for reduction in the middleman's profit.

* Amla, Jackfruit, Jamun, Guava, Kiwi, Olive and other indigenous, newly coming-up fruits and vegetables should be looked into for value addition so as to boost their export in other needing countries.

* In many vegetable crops, suitable varieties for processing are available. The value addition aspects, therefore, need to be considered for boosting exports of fresh and processed vegetables. Likewise, varieties in fruit crops need to be identified for such purpose. In this direction, the research on use of natural colours should be encouraged.

* To meet WTO obligations in the years to come, the politicians, bureaucrats and technocrats need to join hands for sustainable production and value addition so as to cater to the needs of domestic and international market.

Toward resource conservation technology in agriculture, the participatory approach of farmers or warabandi system of irrigatioin need to be adopted with the help of line departments. There should be a phased closure of canal system. Water treatment plants should be developed for the treatment of water which gets polluted due to leather industry.