PROCEEDINGS OF THE

32nd IAUA VICE CHANCELLOR'S ANNUAL CONVENTION

ON

DIVERSIFICATION IN INDIAN AGRICULTURE

December 20-21, 2007

Sponsored by
INDIAN AGRICULTURAL UNIVERSITIES ASSOCIATION, New Delhi
and
Organized by
BIRSA AGRICULTURAL UNIVERSITY, RANCHI - 834 006

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Edited by:

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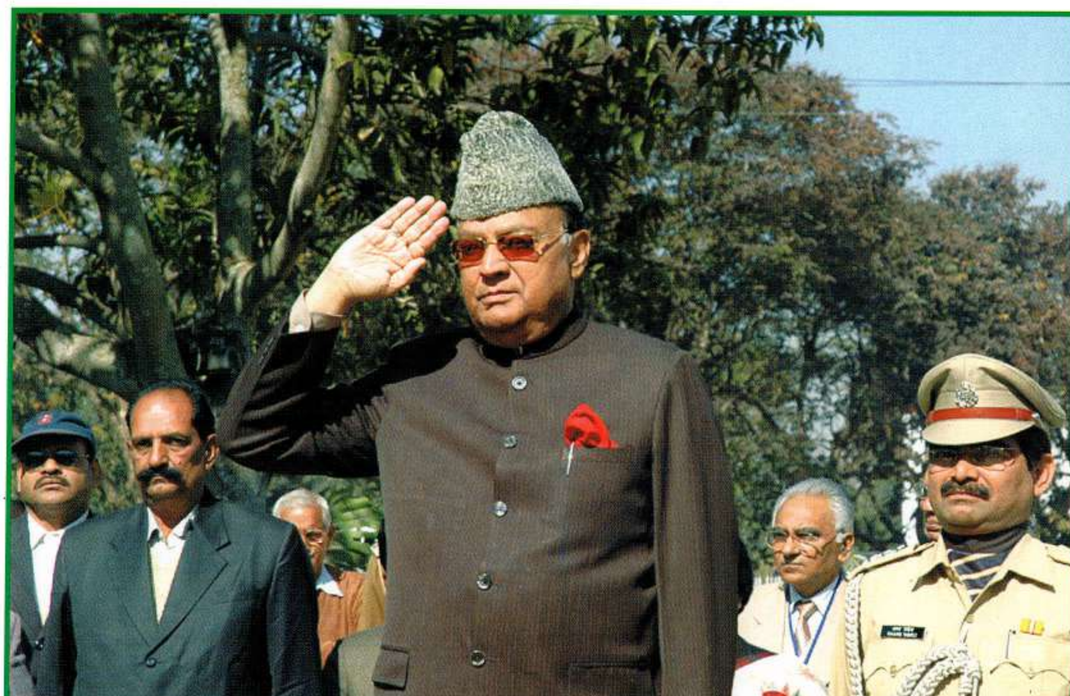
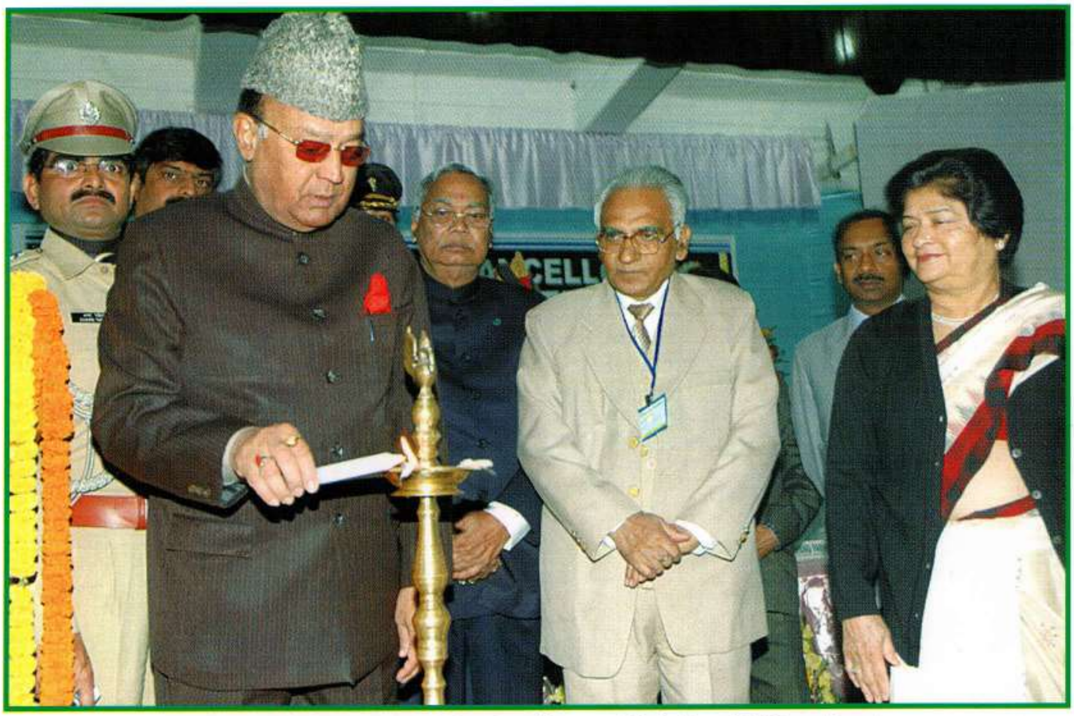


Guard of Honour to His Excellency, Shri Syed Sibtey Razi,
Governor and Chancellor of Universities of Jharkhand



Lighting of Lamp by His Excellency, Shri Syed Sibtey Razi,
Governor and Chancellor of Universities of Jharkhand

Lighting of Lamp by Dr. M.P. Yadav, President, IAUA

PROCEEDING OF THE 32ND IAUA (VCs) ANNUAL CONVENTION ON DIVERSIFICATION IN INDIAN AGRICULTURE HELD AT BIRSA AGRICULTURAL UNIVERSITY

The 32nd IAUA (VCs) annual convention was inaugurated by His Excellency, Governor and Chancellor of Universities of Jharkhand, Shri Syed Sibtey Razi on 20 December, 2007. First of all Kulgeet was Sang by Students of this University and lighting of lamp was done by His Excellency to formally inaugurate this convention. First lady of Jharkhand Mrs. Chand Farhana also graced the occasion by her presence. On the stage alongwith other dignitaries Shri Amit Khare, Principal Secretary to Governor was also present. Dr. M.P. Yadav give his president remarks about this convention. On this occasion Vice Chancellor of BAU Dr. N.N. Singh welcomed the delegates. He said that Indian agriculture has been undergoing spectacular changes in recent period. These changes are manifestations of large scale commercialisation and diversification taking place in the agricultural sector. They broadly include cultivation of new crops and varieties, increase in the share of area under cash crops, large scale spread of livestock activities and fisheries, pursuance of hi-tech agriculture in the areas of aquaculture, bio-technology, horticulture, processing, etc. The latest changes are basically responses of our agriculture to new economic environment ushered in by the process of liberalisation.

In the past few decades India has seen a sustainable growth in food production and incomes along with growing diversification both in consumption and production. Food security and sustainability our major goals to keep agriculture sector out of a danger zone seems to be have been fulfilled. But this feel good factor seems to be a myth as we see new and bigger challenges emerging in this most vulnerable sector. Share of agriculture in country's GDP has declined from 48.7% in 1950 to 24.4 % in 1996-97 and further 18.7% in 2007. Agriculture sector is the backbone of country's development and lifeline for 65 per cent of the population based in rural areas and approximately more than 58 percent of the population still dependent on agriculture for their livelihood. Besides this to achieve an ambitious rate of growth for the country of as high as 9-10% in the eleventh five year plan, the country needs a strong pull-up support to agriculture sector which should grow at least at the rate of 4 per cent per annum, all the more since in 2005-06 the growth in agriculture was merely 2.2% which is expected to go even negative next year.

Besides basic food grain production, other agricultural activities like livestock, fisheries, horticulture, organic farming commercial crops, agro processing are the new avenues in the agricultural sector which will lead us in the next phase of agricultural development. Along with this what is needed most important is to efficiently use the existing agriculture setup and upgrade it to reap the best results. The prevailing policy instruments need to be re-looked, re-defined, re-written and efficiently implemented to take care of the prevailing loopholes. One such important factor is the linking of the markets domestic and international through efficient supply chain. The must need for today is the public private partnership, not only in investment but also in the research, extension and policy implementation. Agriculture sector reforms should be initiated at war-footing, to bring together all the best that's available and make agriculture an organised unit to give farmers the maximum benefits. Turning agriculture into an organised business with the farmer as the entrepreneur should be the key to the second green revolution and for the much desired evergreen revolution in India. Farming should be taken up with the motive of profit making rather than just making a subsistence living. With huge diversity in thenumber and variety of crops that we produce, variations in agro-climatic conditions, soil type, prevailing inequalities in the state growth levels, it is utter most essential to implements the plans through micro level initiatives and proper coordination between all the stake holders. These issues need to be considered to meet the targets laid out in the eleventh plan strategy to raise agricultural output.

Dr. R.P. Singh, Executive Secretary, IAUA said that the idea behind forming this association is to promote agricultural research, education and extension in the Universities and states and thereby bringing rural development in the country. Therefore, this convention is organised once every year to strengthen the linkages amongst all its members. Chief Guest, Shri Syed Sibte Razi delivered his inaugural speech.

Inaugural Address of Chief Guest His Excellency Shri Syed Sibtey Razi, the Governor and Chancellors of Universities of Jharkhand in the 32nd Annual Convention of Indian Agricultural University Association

Smt. Chand Farhana, First Lady of Jharkhand, Dr. M P Yadav,President Indian Agricultural University Association, Dr. N.N. Singh, ViceChancellor, Birsa Agricultural University, Sri Amit Khare, Principal Secretary to Governor, Dr. R.P. Singh 'Ratan', Director, Extension Education, Birsa Agricultural University, all the Vice Chancellors' of Agricultural Universities from different corners of the country, other delegates, scientists, press and media persons.

It is a matter of great pleasure for me to be with all of you this morning to address this august body of agricultural scientists, who have gathered here on the occasion of 32nd Annual Convention of Indian Agricultural University Association, to discuss on the topic of Diversification in Indian Agriculture. As Chancellor of the Universities of Jharkhand I feel proud that such a conference is being organized by the Agriculture University of my state and I congratulate the Vice Chancellor Dr. N. N. Singh and his colleagues for organizing the same.

Poverty in India is predominantly a rural phenomenon. About 70% of the population, and about 75% of the poor, live in rural areas and most of them depend on agriculture. Agriculture provides livelihood to 60 percent of the rural people and remains vital for food security. In recent years, the slowdown in agricultural growth has become a major cause for concern. In the past few decades India has seen a sustainable growth in food production and incomes along with growing diversification both in consumption and production. Food security and sustainability has been one of our major goals to keep agriculture sector out of a danger zone seems to be have been fulfilled. But this feel good factor seems to be a myth as we see new and bigger challenges emerging in this most vulnerable sector. Share of agriculture in country's GDP has in fact declined from 48.7% in 1950 to 24.4 % in 1996-97 and further 18.7% in 2007.

The increasing economic integration of the Indian economy with global processes has also brought considerable challenges at the door of its agricultural sector. These challenges have arisen from two broad sets of problems. In the first place, a number of major crops have been witnessing a decline in productivity growth, in particular over the past decade. Second, and perhaps more important from a short run perspective, is the fact that Indian agriculture faces unfair competition from cheap imports, which poses an enormous threat to the livelihoods of the farming communities. It is quite clear, therefore, that a comprehensive framework needs to be evolved, one that addresses the specific problems that the agricultural sector faces at the present juncture.

Agriculture sector is the backbone of country's development and lifeline for 60-65 per cent of the population based in rural areas and approximately more than 58 percent of the population still dependent on agriculture for their livelihood. Besides this to achieve an ambitious rate of growth for the country of as high as 9-10% in the eleventh five year plan, the country needs a strong pull-up support to agriculture sector which should grow at least at the rate of 4 per cent per annum, all the more since in 2005-06 the growth in agriculture was a mere 2.2% which is expected to go even negative next year.

Besides basic food grain production, diversification on other agricultural activities like livestock, fisheries, horticulture, organic farming commercial crops, agro processing are the new avenues in the agricultural sector will lead us in the next phase of agricultural development. Along with this it is important to efficiently use the existing agriculture setup and upgrade it to reap the best results. The prevailing policy instruments need to be re-looked, redefined, re-written and efficiently implemented to take care of the prevailing loopholes. One such important factor is the linking of the domestic and international markets through efficient supply chain. There is a need for public private partnership, not only in investment but also in the research, extension and policy implementation. Agriculture sector reforms should be initiated at warfooting, to bring together all the best that is available and make agriculture an organised unit to give farmers the maximum benefits. Turning agriculture into an organised business with the farmer as the entrepreneur should be the key to the second green revolution and for the much desired evergreen revolution in India. Farming should be taken up with the motive of profit making rather than just making a subsistence living. With huge diversity in the number and variety of crops that we produce, variations in agro-climatic conditions, soil type, prevailing inequalities in the state growth levels, it is essential to implement the plans through micro level initiatives and with proper coordination between all the stake holders.

Since the first green revolution in 1960's, the food grain production in our country has increased significantly from 82 million tonnes in 1960-61 to 129 million tonnes in 1980-81 and 213 million tonnes in 2003-04, to meet out food security and attain self sufficiency specially in the production of our stable food rice and wheat. Green Revolution introduced the use of improved inputsfertilizers, pesticides, seeds and irrigation facility. But the impact of green revolution was mostly evident in areas with irrigation facilities. In late 1980's, the country saw another set of reforms initiated by broad trade liberalisation and depreciation of exchange rate, which made the terms of trade in favour of agriculture. These reforms were focused on liberalisation of export trade mainly due to some surpluses created in rice and wheat. But overall, in recent year's our economy has seen a decline in the rate of growth of agricultural sector and also its share in GDP.

Strengthening of agriculture will not only help in upliftment of the farmers but also benefit the larger section of the rural poor who are directly engaged in agriculture or indirectly linked with agriculture as consumers. Efficient way of production, stabilized prices, higher income from agriculture would create a more conjugative environment in the country for the development of the economy as a whole and of rural population in particular. An important component of the much needed reforms is not only implementation of the policy in time but also simultaneous review and evaluations of the impact of the policies and taking immediate steps to rectify the negative impacts if caused by any of the policies. Inter sectoral linkages and organisation of the agricultural sector needs to be taken up. Sustainability is another key issue. In the present context sustainability with natural resource management has become more relevant. The visible institutional changes with new models of marketing and cultivation should be supported by government policies too. Priority areas for investment need to be identified and worked on without loss of time. Risk management and incentive based system will motivate farmers to efficient agriculture. Empowerment of the small and marginal farmers through education, reforms and development will ensure a better, efficient and strengthened Indian agriculture. Motivation regarding new models in production and marketing along with creating awareness and imparting education to small farmers will help in development of the sector and more importantly improving the economic status of poor farmers. The action plan to strengthen agriculture in India needs to focus on domestic reforms and while on the hand, government intervention in the market economy should be reduced on the other hand state government must play a major role as evaluator and implementation of the policies, increased investment and prioritizing the area to invest, parallel action plans in this direction are needed in research to increase productivity and irrigation and water management.

Never did Indian Agriculture, after attaining Green Revolution, receive so much attention as now. There is now an urgent need for a paradigm shift in agricultural policy to address the problems facing the agricultural sector in the new economic environment, domestic and global. Diversification of Agriculture (DOA) has been adopted as a strategy for enhancing incomes of the farmers in different parts of the World. Diversification of Agriculture (DOA) as a strategy would, to

Welcoming His Excellency, Shri Syed Sibtey Razi,
Governor and Chancellor of Universities of Jharkhand

Welcoming First Lady of Jharkhand, Smt. Chand Farhana

Welcoming Shri Amit Khare, Principal Secretary to His Excellency, Governor and Chancellor of Universities of Jharkhand

Welcoming Dr. M.P. Yadav, President, IAUA a large extent, open up opportunities for value addition in agriculture and enhanced income earning opportunities for the farming community.

I am quite confident that after two days of discussion by the galaxy of Agricultural Scientists, many issues will come to the fore front, which will be basis for policy makers to plan in such a way that growth rate in agricultural sector should increase on a sustainable basis not only for the benefit of 70 per cent poor peasants of this country but also for the sustainable economic development of the country. With these words, I inaugurate this 32nd Annual Convention of Indian Agriculture Universities and extend my best wishes to all the participants for the success of this Convention as also for a very happy new year.

At the end vote of thanks was given by Dr. R.P. Singh 'Ratan', Director Extension Education, BAU.

National anthem formally marked the end of the inaugural session. Dr. Niva Bara managed the stage of this occasion.

The 32nd IAUA VCs Annual Convention on Diversification in Indian Agriculture was divided into total nine Technical Sessions and all the Sessions were held in the Senate Hall of the BAU.

TECHNICAL SESSION-I

Diversification in Indian Agriculture vis-à-vis resource utilization.

Chairman: Dr. Gautam Kalloo, Vice Chancellor, JNKVV, Jabalpur

Co-Chairman: Dr. K.R. Kaundal, Joint Director, IARI, New Delhi

Invited Papers:

1. **Dr. S.S. Baghel,** Vice Chancellor, AAU, Jorhat emphasized on the occasion that:
   - Diversification is a response to the market driven economy. Diversification must be related to food habit.
   - Contract farming is going to be talk of the nation in time to come.
   - Massive education programme backed by infrastructure and policy support is needed to change mind set of farmers to produce more.
2. **Dr. Gautam Kaloo,** Vice Chancellor, JNKVV, Jabalpur also stressed that:
   - Food employment security and economic security is the main purpose of diversification.
   - Depletion of natural resources is most important challenge before us.
   - Ensuring proper input supply, value addition, marketing and credit structure will solve deteriorating status of farmers.
   - Wasteland utilization will help in speeding up diversification, process. Input efficiency has to be increased.
   - Precision farming will ensure optimization of inputs and will bring resource use efficiency.
   - There is a great scope of protected cultivation.
   - Series of network of projects are required for hi-tech agriculture.

Views of panelists:

1. **Dr. Dilip Kumar,** Director, CIFE, Mumbai remarked that:
   - ➢ Micro level approach is required to increase production and productivity.
   - ➢ Safeguarding the traditional practices in agriculture.
   - ➢ Judicious Water management is needed.

2. **Dr. S. Kumar,** Head, HARP, Ranchi pointed out that:

   - Areas like food distribution system, agro-processing, health facilities and market reforms are needed to bring diversification in Indian Agriculture.
   - Inter ministerial and inter-disciplinary approach is needed.
   - Minimizing the man made uncertainties in agriculture.

3. **Dr. R.P. Singh 'Ratan',** Director Extension Education, BAU emphasized that:

   - Level of technologies that has reached to the farmers is very low, but farming system in this state is already diversified.
   - Training of scientists is needed for diversification management.

Repporteards:

- Dr. A.K. Singh,
- Dr. Chattopadhyay,
- Dr. Atul Kumar

TECHNICAL SESSION-II

Sustainable utilization of plant, animal, microbial and natural resource diversity for agricultural production and augmenting income and employment.

Chairman: Dr. M.P. Yadav

Co-Chairman: Dr. Dilip Kumar

Invited Papers:

Diversification in Indian Agriculture for Augmenting Income and Employment with Special Emphasis to Livestock Sector

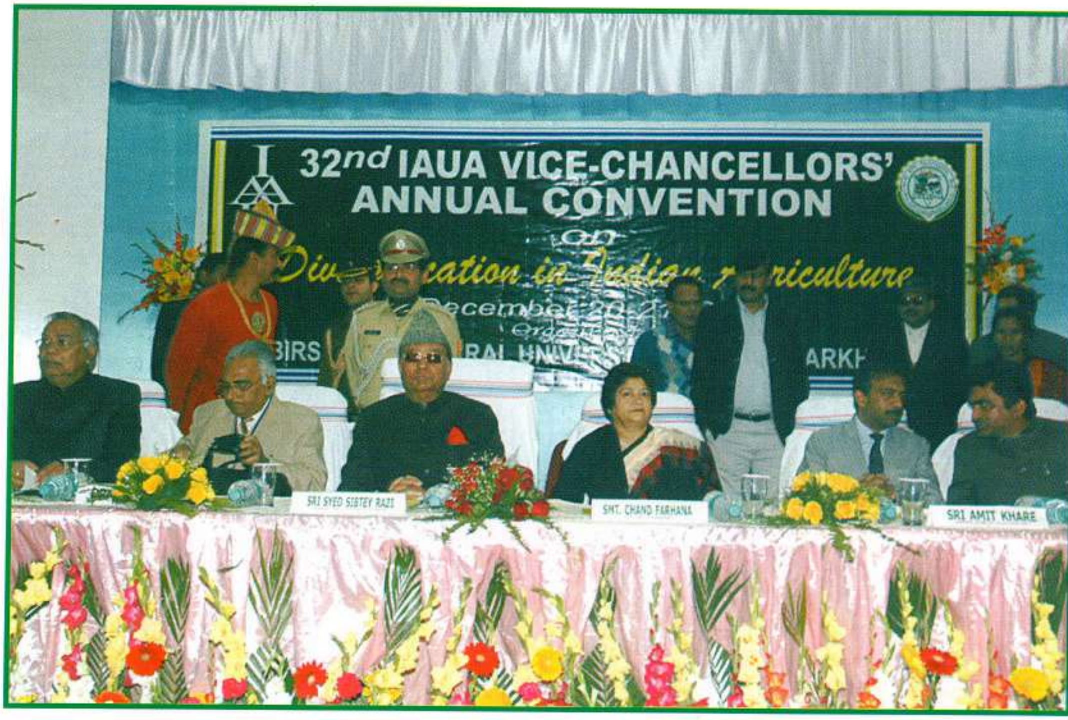
Prof. C. S. Chakrabarti,
Vice-Chancellor,
West Bengal University of Animal & Fishery Sciences,
Kolkata.

Preface:

India is an agriculture based country. Although the contribution to GDP from agriculture is comparatively less than the industry and service sectors but more than 60% of Indian population are directly or indirectly associated with the agriculture. That is, two thirds of the workforce in India maintain their livelihood from agriculture. Over the years the agricultural lands are getting reduced due to many reasons but dependence on the agriculture is gradually increasing. The success of first green revolution gradually becoming a story of yesteryears. Necessity for second green revolution has become a demand of the day. After first green revolution, Indian agriculture has been one of the greatest success stories. That was possible due to addition of new areas under cultivation, providing irrigation facilities, applying high yielding crop seeds and chemical fertilizers and pesticides and using advanced technologies available in those days. Above all, the hard labour given by the farmers and scientists deserved special mention.

Present Status :

However, in the recent decade, the situation have changed a lot. Agriculture in India has arrived at a critical point. Production of many agricultural products have reached to the point of stagnation. Some reasons behind this include :



Inauguration of 32nd IAUA Vice Chancellor's Annual Convention

Inaugural Speech of His Excellency, Shri Syed Sibtey Razi,
Governor and Chancellor of Universities of Jharkhand

National Anthem at Conclusion of Inaugural Session

- Loss of fertility of the soil,
- Scarcity of irrigation water,
- Unscientific use of chemical fertilizers and pesticidesSpurious seeds, fertilizers and pesticides,
- Improper use of scientific technologies,
- Lack of interest for crop rotation and crop diversification,
- Rapid and irratic climatic behaviours,
- Spread of diseases and pest infestation,
- Less incentives from the agriculture,
- Initial investment very high and risky too.

However, we get encouragement from the following statement by Dr. Mangala Rai, D.G., ICAR:

"Agriculture must continuously evolve to remain ever responsive to manage the change and to meet the growing and diversified needs of different stake holders in the entire production to consumption chain".

Crop diversification :

India is a big country. In many respect our country resembles the feature of a continent. We have very big mountain ranges on the northern part of the country and the other three sides are bordered by vast marine water bodies. We have desert lands, plain cultivable lands, forests and large water bodies. Due to diversified physiographic conditions, large varieties of flora and fauna are available in this country. Availability of irrigation water, density of rainfall and the general climatic condition are a few parameters which determine the nature of the crop. In different parts of India several indigenous varieties of paddy plants are available. Similarly several varieties of other cereals and non-cereal crops, pulses, vegetables and fruit plants are found in different parts of India.

However, for the production of more crops, cereals, pulses, fruits and vegetables appropriate technology based agriculture methodologies are needed. During Green Revolution high yielding varieties of crops were successfully grown in our country by the farmers. For further growth in the field of agriculture appropriate policies and their implementation in the fields are very important. Application of pest resistant high yielding varieties of seeds, rainwater harvesting, organic farming and crop diversification are among the various systems should be followed to make next green revolution a grand success.

Animal husbandry and Dairy development:

Animal husbandry and Dairy sectors provide unique opportunity for the generation of rural employment and thereby can strengthen primarily the rural and secondarily the urban economy. We get animal proteins mainly from meat and milk. In the 10th 5 Year Plan period West Bengal has made tremendous advancement in the development of animal husbandry. Development in poultry, piggery, goatery, duckery sectors and in the production of eggs are noteworthy but still there is a gap between the production and demand. Therefore, there is a big scope for further development in these sectors. This development can be done not only by encouraging the big farmers but also by promoting animal husbandry at the village level.

West Bengal and its animal resources :

West Bengal is rich in animal resources. These include Black Bengal Goat, Garol Sheep of South Bengal, Banpala Sheep of North Bengal, Ghoongru Pig of North Bengal. Besides these special varieties of fowl and ducks are also available in West Bengal. West Bengal occupies first position in regards to the density of cattle population. But from the point of milk production these cattles are not economical. In India West Bengal holds eleventh position in milk production and fifth position in egg production. In regards to the number of chicken West Bengal occupies second position, first position in regards to its own varieties of duck. First position also in regards to the number of goat. An addition to these animal resources, West Bengal occupies first position in the production of fishes. In spite of these, there is a big scope for further development in animal husbandry and fishery sectors.

Poultry Development :

At present West Bengal State Government is maintaining 22 State Poultry farms for layer parent stock and for selling hatching eggs and one day old chicks. Besides these Govt. is also encouraging poor farmers under specific schemes for the development of poultry at the rural level.

Piggery Development :

State Government has established a big piggery station at Haringhata and some small stations in other parts of the State for promoting piggery among the interested villagers. Our University (WBUAFS), is maintaining a very special type of pig called

"Ghoonghru pig" which is available in some northern Districts of West Bengal. ICAR sponsored research projects on this pig is going on in our University.

Goat and Sheep development :

For the production of meat and good quality skin, State Government has set-up five sheep and seven goat farms. Among the sheep, two varieties are "Garol" and "Banpala" available in the southern and northern parts of West Bengal. Special research works are going on under the aegis of West Bengal University of Animal & Fishery Sciences for the genetic identification, conservation and production of these sheep. Similarly, the most famous goat variety of West Bengal is Black Bengal Goat. This is a very good variety of goat, which provides good quality meat and world class skin. On the identification, genetic characterization, conservation and propagation of this goat, ICAR sponsored AICRP projects are going on in our University. Few villages have been selected for these project works, where villagers are rearing these animals under the guidance and supervision of the University scientists.

Cattle development :

The main purpose of cattle development is to get the require quantity of milk. According to State Govt. information during 2005-2008 the production of milk was 3,801,00 MT, during this period the requirement was 5267,58 MT. Therefore, there is a big gap between the production and requirement. There is a big scope for the development in this sector. West Bengal's local cattle varieties are not very significant from the point of milk production. Practical and pragmatic breeding policies can bring good result in this sector. However, for the improvement in this sector appropriate systems to be developed for the production of feed and fooder.

Aquaculture :

West Bengal has both sweet water and marine water aquaculture facilities. Sweet or inland water bodies include 2.76 Lac. Ht. Ponds, 0.442 Lac. Ht. Beel and Baur, 0.176 Lac. Ht. Reservoirs and 4013 Ht. Sewage water bodies. Besides these, West Bengal has 158 Km.

Coastal lines which includes the largest mangrove forest – Sundarban and vast stretch of estuarine areas in the southern part of West Bengal. Sundarban and its adjoining areas are rich in biodiversity including fish, prawn and crabs. Although fish production from both culture and capture fishery sectors are steadily increasing in West Bengal, but still there is gap between the rate of production and rate of consumption because majority of West Bengal population consume fish. Since Govt. of India earns a lot of money from aquaculture, special cares to be taken to solve the problems which are inhibiting the progress of aquaculture.

Integrated farming for rural economic development :

In West Bengal a large number of farmers are small and marginal. Many rural people are without any farm land. Rural economy can be developed by converting these backward villages into animal resource villages by introducing integrated animal farming system. This can be achieved by introducing any of the following integrated animal farming system. By imparting training and providing necessary logistic supports to the farmers and more specially women members of the farmers an alternate livelihood can be developed.

A few models for integrated farming :

- Cattle + Fowl + Duck
- Goat + Fowl + Duck
- Cattle + Goat + Fowl/Duck
- Pig + Duck + Fowl
- Cattle + Pig + Poultry birds
- Sheep + Duck + Fowl
- Cattle + Sheep + Poultry birds.

From survey it has been found that in almost all villages in West Bengal some forms of animal keeping including backyard poultry and duckery do exist. Farmers are habituated with traditional animal keeping activities. But scientific knowledge of animal husbandry and proper management skill are not there. If the selected people are trained properly by the University through the extension activities and by KVKs and monetary and logistic support is provided by the Government for maintenance of more than one type of animal in the same house-yard in an integrated manner, then this could be an alternative livelihood for the rural mass.

Organic farming :

A very good integrated animal and fish integrated culture system can be introduced among the farmers having even small area of water-bodies in their house or in a village. The waste materials obtained from the animal husbandry can be applied in ponds for the cultivation of suitable fishes. Thus organic fish farming system can be developed.

Suggestions for effective integrated animal farming :

01) Selection of some village for the development of animal resources.

02) Identification of interested farmers with special emphasis to the women folk and imparting training on the modus operandi of integrated farming.

03) Special research grants from I.C.A.R. for the implementation of integrated animal farming concept. Necessary financial supports also from the State Government.

04) Sanctioning loan with soft interest to the farmers and one time initial fund for the people living below poverty line by the Governments.

05) Supply of disease free good variety animals to the farmer by Government or Government approved agencies.

06) Proper health care camp in the villages by the experts of the University and the concern Department of the Government.

07) Collection, preservation and marketing of the produce by cooperative system and or by self-help groups.

08) Recycling of animal waste for organic farming and integrated animal cum fish farming.

09) Insurance coverage for the animals.

10) Constant vigilance, data collection and information networking for proper management.

Concluding remarks :

For the livelihood of rural mass along with crop diversification a total farming system in an integrated manner is needed.

ROLE OF MICROORGANISMS IN THE DIVERSIFICATION OF INDIAN AGRICULTURE

Dr J H Kulkarni
Vice Chancellor
University of Agricultural Sciences, Dharwad
Dharwad - 580 005

Abstract

Agricultural diversification as a strategy to achieve important development goals has received increased attention of policy makers in the country during the recent years. The strategy envisages changes in production activities of farm sector, to adjust to changes in economic environment and to face the challenges of persistent unemployment and natural resources degradation. The broad objectives of this strategy are to raise per capita income through opening of avenues for productive employment in farm and non-farm sectors, and to make the economic growth broad based and sustainable in the long run.

Success of the diversification process in the agricultural sector resides in the production of quality products which is demanded by the local market and/or the export market. This production should be both economically and ecologically sustainable through the use of new technologies available in agriculture. The prospects of microbial technologies in Indian agriculture are immense. They offer many avenues in agriculture for diversification and sustainability.

In agriculture, microbial biotechnology covers a wide array of subjects ranging from biofertilizers to biological control of pests and diseases; from biological N_2 -fixation to lignocellulose degradation; from production of biomass and biofuels to genetically engineered plants. The various ways in which microorganisms can be used would include the production of recombinant vaccines and medicines such as insulin; growth hormones, interferon, enzymes and special proteins. Recombinant vaccines have considerable application: not only can they be produced inexpensively but they also offer the advantages of safety and specificity, and allow the easy distinction between vaccinated and naturally infected animals. Modification of starter organisms presents opportunities for improved organoleptic properties and shelf life of milk and meat products as well as more predictable fermentation rates to facilitate mechanization. Organisms have been developed for bioremediation of land and water, for biological control and environment quality enhancement. Improvement in the rumen digestive system through microorganisms that can enhance the accessibility and utilization of nutrients by the animal is also possible.

Livestock Biodiversity - a key to diversification in Indian agriculture

Dr S P S Ahlawat
Director, Indian Veterinary Research Institute,
Izatnagar – 243 122 (UP)

Although agriculture contributes only a fifth of India's GDP, its importance in the country's economic, social, and political fabric goes well beyond this indicator. This sector plays a crucial role in sustaining national economy through its contribution to food, nutrition, energy, income and employment to millions of Indians belonging to rural sector particularly among the landless, small, marginal farmers and women. In this sector, the poor contribute to growth directly instead of benefiting from growth generated elsewhere. After the Green Revolution of the 1960s which enabled India to achieve self-sufficiency in food grains, there has been spectacular growth in agriculture production during next 30-40 years and India's food grain production rose from 50 million tones to 220 million tones. However, this growth has slowed - from 3.5 percent in mid 1980s to 1990s to less than 2 percent in mid 1990s to 2000s. Decline in size and land holdings, fatigue technologies, depleting soil quality and diminishing returns have brought down the agricultural growth and the consequent widening of the gap between rural and urban incomes has become a major cause for concern. The Government of India is therefore placing high priority on diversification of agriculture production by adopting new approaches so that not only food security is maintained but also the rural poverty is reduced at the earliest.

What is Agricultural Diversification?

While Indian agriculture has seen a traditional production of important self-consumption food grain for many centuries, a time has come when farmers feel need for diversification not only to make agriculture a commercial entity but also to meet his own nutritional security from allied sources. Diversification is usually defined as a shift to high-value commodities, fruits, vegetables, milk, meat, eggs, fish and spices. This shift can be at macro level like from farm to non-farm activities, from non-commercial to commercial commodities or to use resources in diverse and complementary activities. Further, the scope of agriculture diversification can also be used at micro level to meet house-hold food security, for minimizing production and marketing risks as well as to generate additional income. The ultimate objective of any diversification measure is to improve farmers' house hold income and nutritional status by enhancing productivity of mixed farming system through better use of natural resources and integration of crop-livestock activities.

Need for Agriculture diversification?

In view of the fact that last two decades have seen near static or even negative growth in Indian agriculture, there is an urgent need to think for more intensive and diversified system to make agriculture a lucrative business. A synergy should be established through land-based enterprises like livestock and fishery, poultry etc and new markets opportunities should be captured through new enterprise including post-harvest and value additions. The diversification has to be practical in the sense that it should include demand driven factors like population growth, rising income, urbanization, dietary changes, changes in taste and preferences and export potentials as well as supply-driven factors like the development of new technologies, resource generation, available infrastructure, development of new institutions and prevailing socio-economic factors.

Is livestock sector an answer?

The overall growth rate in livestock and poultry sectors in India has been moving steadily at 5-6%. Livestock sector has been contributing about 25-30 percent of the value of the output from total agriculture and allied sector. Development of Animal Husbandry has been an integral part of diversified agriculture as milk, egg, meat and wool production of the country has recorded impressive growth at the rate of 4.5, 5.7, 5.0 and 1.62 % during 2004-05. With a large livestock population of 485 million supported by 489 million poultry population, Indian share to world population of cattle, buffalo, goat and sheep comes to about 14, 57, 15 and 6 % respectively. This livestock wealth of India is responsible for production of about 100 million tones of milk, 44 billions of eggs and 1.6 billion broilers annually and making this country as the first and fourth in the world ranking. All these encouraging figures suggest that livestock sector can be an ideal means of agricultural diversification in India. This is particularly more important in a country like India where, food consumption pattern is gradually diversifying in favour of non food-grain items like milk, meat and eggs. These changes in diets of millions of people will create a massive increase in demand for food of animal origin, which could provide income as well as growth opportunities for many rural poor. But such demand driven growth will require serious attention to improve production from the existing livestock and poultry resources.

Looking into the potential benefits of Livestock and poultry sector in building a progressive, healthy and prosperous rural India, a sustainable and financially viable livestock and poultry farming, which will generate wealth and self-employment through entrepreneurship, is the need of the day. In this context, sustainable use of livestock biodiversity available in India can be answer to many of these problems.

Livestock Biodiversity of India:

India is the mega biodiversity resource centre of the world and occupies a prominent position both in respect of wild and domesticated flora and fauna. The agro biodiversity is represented by a rich variety of plants of food and economic values and domesticated animals. Animal husbandry has always been an integral part of Indian civilization and our country possesses rich biodiversity of animal genetic resources which are spread over diverse agro-climatic regions. These resources have been developed by our ancestors over several generations and have acquired special attributes like remarkable adaptability to environment, management conditions and genetic resistance to most tropical diseases besides survival on poor quality of feed and fodder. *In spite* of multiple threats of change, replacement, degradation and extinction, this biodiversity of farm animals comprises of 30 well-described breeds of cattle, 10 of buffaloes, 20 of goats, 42 of sheep, 8 of camel, 6 of horses, 20 of poultry besides large number of variants of native ponies, pig, donkey, yak and mithun. This mega-diversity is not accidental, nor it is purely natural, rather, it is the outcome of thousands of years of deliberate selection and planned exposure to a range of natural conditions.

The indigenous livestock breeds were developed for their utility under a certain set of agro-climatic conditions and many of such breeds developed some unique traits which not only distinguish them from others but have a special economic role to play. There is large genetic diversity in livestock as reflected in important domesticated species and a large number of known and less known breeds/strains. There are nearly 140 breeds of livestock and poultry in India, sustaining Indian agriculture for centuries. The preservation of such a huge biodiversity for all these years has been primarily because of traditional wisdom, social and economical values in sustainable management of animals and their environment and meeting their both ends in the bargain.

Cattle

There are 30 well defined breeds of indigenous (*Bos indicus*) cattle, spread over the entire country. If we look back to the spectrum of cattle diversity in India, it would reveal a well planned strategy by agricultural geniuses of the country. The milch breeds like Sahiwal, Red Sindhi, Gir, Rathi, Tharparkar have been developed in arid, semi arid desert ecosystem where agriculture was not developed and the animal's milk was the only source of livelihood for the farmers living almost in nomadic way due to regular draughts. In the Indo-Gangetic plains and other irrigated areas duel propose cattle breeds like Hariana, Kankrej, Ongole, Kangayam emerged by providing good bullocks for agriculture while females provided some milk for farmer's families. In other areas, the draft cattle breeds of desired body frame and strength were evolved for meeting the agricultural requirements depending upon the type of soil and agro-climatic conditions. In this process, unique draft cattle breeds like Nagauri, Amritmahal, Hallikar, Khillari, Malvi, Namari, Kenkutha, Dangi, Krishna Valley, Bargur, Umblecherry, Kherigarh, Ponwar, Bachaur were developed.

Buffalo

India is considered as the motherland of world's best Riverine buffalo breeds like Murrah, Nili-Ravi, Surti, Jaffrabadi, Nagpuri, Mehsana. Bhadawari is a unique breed known for high fat percentage (8-13 %) in milk. Toda is a unique hill buffalo. Small populations of buffaloes in Orissa have also developed some unique features and are named differently.

Kaziranga buffaloes are considered as direct descendents of Wild Asiatic buffalo. The buffaloes have been contributing nearly 57 percent of total milk production in the country while the surplus males are used for draught purposes.

Sheep

The spectrum of sheep breed diversity is most pronounced in India where 42 well defined breeds are found in almost all the agroclimatic conditions ranging cold arid to hot arid, semi arid to hot humid and coastal ecologies. Like other species, the sheep breeds from North temperate Himalayan region are predominantly of fine wool types, sheep from dry Northwestern parts have medium type carpet wool. The sheep from southern plateau are hairy and mutton types. The sheep breeds from coastal ecology are small and known for high fecundity.

Goat

Among 20 breeds of goats, Jamnapari, Barbari, Beetal, Surti,. Mehsana, Kutchi, Marwari, Sirohi, Zalawadi, Sangamneri and Malabari produces milk while males are used for meat production. There are some excellent meat type goats like Black Bengal, Osmanabadi, Kannaidu, Kodiadu, Ganjam which are prolific and have higher feed conversion efficiency.

Camel

In addition to important breeds of camel viz. Bikaneri, Jaiselmeri, Kuchchi and Mewati, Malvi, there are less known breeds such as Marwari, Mewadi, Sindhi, Shekawati. These animals are still a major livestock for transport and draught work in desert of Rajasthan. Double hump camel of Nubra valley are very few (< 100). Double hump camel is adapted under cold aid ecosystem of Ladakh.

Horses

Little efforts for description and evaluation of indigenous breeds of horses and donkeys have been made. Breeds like Marwari, Kathiawadi, Zanskari, Spiti, Manipuri and Bhutia are some important breeds would need immediate attention for conservation and improvement. Marwari horses are known for agility and special senses. Zanskari horse breed is adapted to work under high altitudes and tolerate excessive cold and hypoxic environment.

Poultry

A number of species of poultry viz. chicken, ducks, Guinea fowl and quail, make important contribution to food and income. Nearly 18 indigenous breeds of poultry (Aseel, Kadaknath, Kashmir Faverolla, Telicherry, Punjab Brown, Kalasthi, Ghaghus, Miri, Anklewshwar, Harianghata Black, Chittagong, Nicobari, Bursa, Deshi Red, Naked Neck, Frizzle Fowl), contributing towards rural poultry are nearly extinct. Aseel breed is one the best fighter bird known in the world, while Kadaknath is known for black meat of medicinal importance. Now these have been replaced by improved layers and broiler breeds on commercial lines.

Other livestock

Very little is known of genetic merits of mules, donkey, and pigs in India. In recent years four kinds of yaks like Ladakhi, Himachali, Sikkimese and Arunachali types have been described in the Himalayan states bordering Tibet. Yaks are known as ship of snow and are lifeline for highland people like reindeer is for Icelanders. Mithun, known as sacrificial ox of India has its limited distribution in NEH states like Arunachal Pradesh, Nagaland, Manipur and Mizoram. Mithun is still used as live currency by the tribal and therefore is status symbol in those communities.

Strategy for Conservation of Livestock Bio-diversity

A number of methods have been used for conservation of livestock genetic resources. These include in-situ conservation of the breeds/populations; cryo-preservation of semen, ova, embryos, skin, blood, DNA fragments etc. These methods are relevant when the breed is rare or near extinction. In India the situation is not so acute as to call for large-scale ex-situ conservation efforts. What is, however, necessary is technology evaluation and perfection at selected institutions which can be used whenever and wherever required.

It is recommended that research institutions of ICAR, Agricultural Universities and other research laboratories initiate programs to study and identify valuable adaptive traits at all levels (phenotypic, genotypic, DNA/RNA levels) and locate structural genes /QTLs responsible for these traits. Special emphasis should be laid on: resistance to various diseases. Resistance to harmful endo- and ecto-parasites, tolerance to large fluctuations in quantity and quality of feed, tolerance to non availability of adequate quantity and quality of drinking water, tolerance to extreme temperature, humidity and other adverse climatic factors, adaptation to low capacity management conditions, ability to survive, regularly reproduce and produce for long periods of time.

Many approaches have been used to stop or reduce the decline of livestock genetic resources, and these models can be mutually supportive for short and long term insurance. "Wise use" forms a highly desirable form of conservation. The maintenance of a breed in its native environment whose components helped it to sustain also satisfies the requirements of Article 8 of the Convention of Biological Diversity, which gives first priority to in-situ conservation. It is therefore, suggested that "wise use" should form the basis for framing conservation policies.

Certain issue related to conservation

1. Incentive to farmers

We still find a large number of cattle owners who want to keep the native breeds rather than crossbred or exotic cows for milk production. Rath tribe found in the border region with Pakistan is reluctant to keep crossbreds as compared to Sahiwal. Namdhari tribe of Gujarat keeps large herds of Gir and Kankrej cattle. These are the farmers who can be appropriately trained, given sufficient incentives and veterinary aid to keep their livestock healthy and productive for *in-situ* conservation of these valuable germplasm. Good quality germplasm must be supplied to them timely to improve their livestock and these breeds become self-sustaining under any livestock production system. During XI plan ICAR has proposed a National Grid for the high quality semen grid and it is expected that this grid will cater to the needs of livestock farmers both in organized as well as unorganized sectors

2. Creation of public awareness

The endangered cattle breeds can be popularized amongst the local people of the area and some tourist interest can be created by wide publicity. Some special product from the endangered breed may be popularized. Publicity in the endangered domestic livestock may be as important as proved in the conservation of wildlife. The conservation in the form of live animals was largely limited to breeds of curious appearance as hobby by individuals. In western countries the Livestock Parks of rare breeds are growing in popularity for show to the public. Elsewhere payments are made to the owners for each animal of a recognized endangered breed which they have and breed regularly. In India, there are some farmers who consider it a status symbol in keeping the purebred animals of popular breeds. Such farmers if encouraged through financial and veterinary help, can be the another success story for the preservation of endangered breeds *in situ-in* India

3. Live animal reserves

It has been globally recognized that there may be a place for the animal resources on the pattern of wild animals. This may help in preserving the natural habitats which include all species of plants, animals and other organisms. In Gujarat, Gir Forest lion reserve can be easily quoted an example where Gir cows are also being maintained by tribals having inside the lion reserve. If managed appropriately, it can be an ideal example of such system to conserve not only the precious germplasm of domestic breed of livestock but also fauna and flora for overall bio-diversity conservation.

4. Legal Frame work

No conservation can be successful unless it is supported by legal support. It is indeed surprising that while there are legal safeguards for the protection of wild life and forest genetic resources, our system does not have enough legal teeth to protect our own indigenous cattle genetic resources. Although, recently, government has enacted a Biodiversity Protection Act where some measures have been suggested to safeguard the national asset of livestock genetic resources. However, still many more constitutional measures are required so that valuable germplasm can be protected and used for the benefit of Indian population.

Views of Panelists:

Dr. B.N. Singh, Director Research, BAU pointed out that:

- Native Rhizobium strains have been isolated from soils of this state which are tolerant to acidic conditions.
- Vermi-compost, bio-fertilizers are very essential in organic farming.

Dr. M.P. Yadav, Vice Chancellor, Sardar Ballabh Bhai Patel University of Agriculture and Technology, Modipuram observed that:

- Technology should provide nutritional security and then only we can have sustainable growth.

Dr. Basant Ram, Vice Chancellor, NDUA&T, Kumarganj emphasize that:

- Organic research areas should be fixed year after year, it should not change. Soil profile, microbes etc. should be studied.

Repporteears:

- Dr. A.K. Singh,
- Dr. Chattopadhyay,
- Dr. Atul Kumar

TECHNICAL SESSION-III

Sustainable utilization of plant, animal, microbial and natural resource diversity for agricultural production and augmenting income and employment.

Chairman: Dr. D.P. Ray, Vice Chancellor, OUAT, Bhubaneshwar

Co-Chairman: Dr. V.K. Suri, Vice Chancellor, CSAUA&T, Kanpur

Invited Paper : No paper was presented on this session

Views of panelists:

Dr. V.K. Suri, Vice Chancellor, CSAUA&T, Kanpur remarked that:

- Organic farming is good for the soil health but right now it is not possible to switch over to it in totality.
- Organic farming can be alternative type of agriculture.
- Experiment should be done to prove the superiority of organic food.
- The premium price on the organic food which decides the economic feasibility of organic farming is needed.
- Policies on organic farming should be framed based on the resources of marginal farmers because they are doing organic farming by default.

Dr. D.P. Ray, Vice Chancellor, OUAT, Bhubaneshwar pointed out that:

- Discussed about the prospects of organic farming in our country.
- Organic farming is feasible in case of integrated approach of farming system.
- Collaborative approach with the NGOs/ SHGs should be developed for promoting organic farming.
- A task force on organic farming should be formed.

- Quality assessment is very important in organic produce.
- Financial and institutional support is needed.
- Referral lab for soil and water analysis is required to be established.
- Awareness about organic farming through training and demonstration is needed.

Repporteears:

- Dr. A.K. Singh,
- Dr. Chattopadhyay,
- Dr. Atul Kumar

TECHNICAL SESSION-IV

Farming system approaches for livelihood security through cropping livestock and other alternatives i.e. mushroom, honey, resin, gums, fisheries etc.

Chairman: Dr. B.K. Kikani, Vice Chancellor, JAU, Junagarh

Co-Chairman: Dr. S.K. Mann, Dean, Post Graduate Studies, PAU, Ludhiana

Invited Papers:

ROLE OF FISHERIES IN AUGMENTING FOOD PRODUCTION AND INCOME OF FARMERS THROUGH DIVERSIFICATION IN AGRICULTURE

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Agriculture in India contributes only 21% of national GDP, but its importance in the country's economic, social, and political fabric goes well beyond this indicator. India has a population of over 1.1 billion people and 72% of them live in rural areas. A large number of these people are poor and depend on rain-fed agriculture and fragile forests for their livelihoods. The Green Revolution of the 1970s enabled the country to achieve self-sufficiency in foodgrains. Agricultural intensification in the 1970s to 1980s saw an increased demand for rural labor that raised rural wages and, together with declining food prices, reduced rural poverty. India continued to experience rapid growth during the 1990s, and its significant economic achievements have helped to lift tens of millions of people out of poverty; by 1999-00, rural poverty was reduced to 26.3%.

The Green Revolution in India was essentially based on commodity, high inputs and high quality land. There was indeed an increase in the food grain production in the 70s ands 80s which made the country to attain self-sufficiency in food grains and also certain segments of the farming community to prosper. However, critics also indicate that poor farmers and those living in the arid, semi-arid, and rain-fed areas did not get the benefit from the Green Revolution. Also, there was an over-emphasis on certain crops that adversely affected a number of endemic varieties.

India's recent growth has had a strong urban bias: while the services sector is booming, agricultural productivity has declined. The share of services in GDP rose to 55.1% in 2006 but there was some deceleration in agriculture, from about 30% two

Technical Session of 32nd IAUA Vice Chancellor's Annual Convention

Technical Session of 32nd IAUA Vice Chancellor's Annual Convention decades back to 21% as on date. This has serious repercussions for nearly three-fourth of the Indian population, which is rural and depends for its livelihood on agriculture as a whole, which also includes fisheries and aquaculture. The widening gap between the economic well being of the rural and urban populations raises serious doubts about the sustainability of our current trend of development. There also remains a substantial disparity of opportunity, particularly in the education, health, and economic prospects of women and other vulnerable groups. In addition, a growing gulf has emerged between Indian states, with the result that poverty is increasingly geographically concentrated.

The Government of India places high priority on reducing poverty by raising agricultural productivity because food production is an over-riding priority, politically, economically and socially for the nation. But, there is only limited scope to expand the area under cultivation, and thus the role of agricultural R&D is critical to enhance agricultural productivity. The strategies that are required to be adopted should aim at enhancing water availability and optimization of water use, as also accrual of the benefits to the rural poor. The only viable solution is a holistic approach in the agriculture sector with complementarity among the various farming practices, including livestock, fisheries, aquaculture, etc. both at individual farm and watershed levels.

India has a long tradition of integrated farming that had a built-in equilibrium and precise balancing of energy, water and input requirements. The crop-livestock integration that has been perfected many centuries back has a sound scientific backing. The ancient combination of Livestock and Crop activities had helped farmers in the past to use the manure as fertilizer for crops, and the crop residues as feed for livestock. The wastes from agriculture such as straw are consumed by the cattle. Straw and other agricultural wastes are composed of cellulose which cannot be digested by humans, but the cellulolytic bacteria in the rumen of the cattle can digest them. Thus the cellulose gets converted to proteins that build up animal flesh. The build up of flesh helps in healthy growth of animals that provide draught power for various utilities such as ploughing, transport, etc., besides human food in the form of milk, meat, etc. The undigested plant materials which come out as animal dung are excellent organic manures for crop and surplus as fuel.

Community village ponds and small irrigation reservoirs are also products of traditional knowledge. These community undrainable ponds are able to harvest, hold, and offer use of water for various purposes, such as livestock, crop/ horticulture, irrigation, and domestic use. It is noteworthy in this regard that the un-drainable ponds also conserve water by effectively harvesting rain water and help in raising the water table. The system also helps to rear fish during the period of hold which can be harvested at any time either for food or for cash income. Due to the carbon dioxide emission, livestock has been designated as a major threat to environment in terms of Greenhouse Gas Emission. But by using cattle dung, the rich phytoplankton produced in the aquaculture ponds utilize the carbon dioxide, much as the terrestrial plants serve as a carbon sink.

Such an integration had been helpful in attaining sustainability in agriculture and allied activities of food-farming. The VAC system of Vietnam involves integration of various farming practices including fish culture in backyard ponds at the household level. This offers cash income and food to the farm family ensuring both livelihood and nutritional security. It also makes it possible to achieve the best of water use optimization. The more recent integration of Fish with the Livestock and Crop has helped to improve both the fertilizer and feed supplies, plus the higher market value of fish as feed and/or food increasing the incomes substantially. Technically, this important addition of a second cycle of nutrients from fish wastes has benefited the enhanced integration process, and has improved the livelihoods of many small farmers considerably. It should be noted that the first of the two cycles of nutrients from the livestock is used to fertilize the growth of various natural plankton in the pond as fish feeds. Yield of fish was increased up to three- to four-fold with polyculture of many kinds of compatible fish feeding at different trophic levels, as practised in China, Thailand, Vietnam, India and Bangladesh. The fish, after consuming the plankton, produce their own wastes that are converted naturally into the second cycle of nutrients, which is then used to fertilize various crops on both the water surface with floats, as practised in parts of China, and on the surrounding dykes.

Aquaculture practiced at the household level, corresponds to horticulture as it is a women-friendly activity. Unlike in agriculture, the fish crop can be harvested at any stage, even partially, depending upon the requirement or need, at any time. The rest of the unharvested crop are able to be held in the ponds and allowed to grow; such a growth is a linear one. It is a readily sellable commodity and can thus be taken out of the pond for any emergency, either for edible purposes or for obtaining ready cash by sale. The ponds have other uses such as for irrigation and household purposes, and in fact, provides for better usage of other crops. Pond humus is also considered to be nutrient-rich organic manure for agriculture/horticultural crops. Pond water is also used for animals for their watering and washing.

Further innovation as well as increased productivity are necessary to push the integrated farming system almost to perfection, on similar lines with what the ZERI (Zero Emission Research Initiative) Integrated Biomass System (IBS) has been trying to do. Livestock waste, which contains very unstable organic matter, decomposes fast and consumes oxygen. So for any specific pond, the quantity of livestock wastes that can be added is limited, as any excess will deplete the oxygen and affect the fish population adversely, even resulting in fish kills.

Digestion of the livestock waste under closed anaerobic conditions, followed by oxidation in open shallow basins with natural algae providing the free oxygen through photosynthesis, before letting the treated waste effluent flow into the fish pond, can convert almost 100% of the organics into inorganics, which will not consume any oxygen to deprive the fish of this important life-sustaining item. So, theoretically, it is possible to increase the quantity of waste ten-fold into the pond without any risk of pollution. Moreover, the big daily increase in readily usable nutrients can be beneficial to the system, provided that they are totally utilized in both fish and crop cultures.

Fish ponds, when integrated into other farming practices, have a number of advantages to offer: any residual organic matter from the livestock waste will be instantly oxidized by some of the dissolved oxygen in the fish pond, with hardly any adverse effect on the big fish population. Moreover, the nutrients are readily available for enhancing the prolific growth of different kinds of natural plankton as feeds for polyculture of 5-6 kinds of compatible fish. No artificial feed is necessary, except locally grown grass for any herbivorous fish.

The fish produce their own wastes that are naturally treated in the big pond to give the second cycle of nutrients, which are then used by crops growing in the pond water and on the dykes. Such a highly-productive bonus is not available in any other farming system. Where some fermented rice or other grain, used for alcohol production, or silkworms and their wastes used in sericulture, are available they are added to the ponds as a third cycle of nutrients, resulting in higher fish and crop productivity, provided that the water quality is not affected. More research and development are required to find more innovative systems of fish, shellfish and crop cultures to use up these nutrients, because any unused parts are potential pollutants. There is also a possibility to precipitate them and sell them as dry fertilizers. Special diffusion pipes are now being tried with compressed air from biogas-operated pumps to aerate the bottom part of the pond to increase plankton and fish yields. A deeper pond than 3 metres of water is also being tried for the same objectives.

Finally, aquaculture as outlined above has the advantage of sustainability, since it **conserves land, water, plant, and animal resources**, is **environmentally non-degrading, technically appropriate, economically viable,** and **socially acceptable."** It conforms not only to the concept of environmental sustainability but also to the most recent perspectives of social sustainability and economic sustainability. It is imperative that certain environmental issues in aquaculture need to be addressed and/or resolved, but it is also equally important to identify those solutions that are viable in the wider context of poverty alleviation and the need to ensure sustained supply of food, particularly in areas where resource-poor segments of rural and urban populations are facing food security problems.

INTENSIVE INTEGRATED FARMING SYSTEM TO BOOST INCOME OF FARMERS

C. Ramasamy* S. Natarajan, C. Jayanthi and D.Suresh Kumar

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I. Why integrated farming system?

India is a country of about one billion people. More than 70 percent of India's population lives in rural areas where the main occupation is agriculture. Indian agriculture is characterized by small farm holdings. The average farm size is only 1.57 hectares. Around 93 percent of farmers have land holdings smaller than 4 ha and they cultivate nearly

55 percent of the arable land. On the other hand, only 1.6 per cent of the farmers have operational land holdings above 10 ha and they utilize 17.4 percent of the total cultivated land.

At the dawn of new millennium, many challenges surmount agriculture to achieve sustainable food security with shrinking land resources. Now we have to produce an additional 50 million tonnes of food grains to meet the requirement of the prognosticated population of 1060 million. Because of declining per capita availability of land in India, there is hardly any scope for horizontal expansion of land for food production. Only vertical expansion is possible by integrating appropriate farming components requiring lesser space and time and ensuring periodic income to the farmer. On the other hand, modest increments in land productivity are also no longer sufficient to the resource poor farmers. Hence, efficient management and allocation of resources are important to alleviate the risk related to land sustainability. Moreover, proper understanding of interactions and linkages between the components help to improve food security, employment generation besides nutritional security. This concept which has got transformed into farming systems approach, envisages the integration of agro-forestry, horticulture, dairy, sheep and goat rearing, fishery, poultry, pigeon, biogas, mushroom, sericulture and by product utilization with crops, with the primary goal of increasing the income and standard of living of small and marginal farmers.

One of the ways to make farming a viable proposition is to bring diversification in agriculture. The preconditions for diversifications are water resources development and growing of crops which have better market opportunities. In addition to growing vegetable and fruit crops, livestock, pisiculture, bee keeping, poultry, rabbitary and floriculture can further provide boost to the overall improvement in the farming business.

II. Overview of farming practices followed

Traditionally, farmers have been practicing cultivation of crops with inclusion of some allied enterprises. Mostly, farmers cultivate various food and non-food crops based on the resource availability. In addition to cropping, other complementary and supplementary enterprises also included in the farming system to better utilize the available resources and enhance farm income.

Cropping pattern

The proportion of area under different crops across regions over the period was examined. The cropping pattern followed by the farmers in Tamil Nadu indicates that the cereals, particularly paddy, sorghum and maize dominate the cropping pattern (Table.1). It is evidenced that the proportion of area under paddy in the farming system is increasing over the years.

Table.1. Cropping Pattern followed by farmers in Tamil Nadu

(Percent)

Crops	1970s	1980s	1990s	2000s
Paddy	35.05	43.03	50.25	55.34
Sorghum	6.77	4.42	4.37	3.95
Bajra	3.44	1.60	1.35	1.14
Maize	0.55	0.66	0.90	2.04
Ragi	2.43	1.50	0.28	0.26
Small millets	1.97	0.62	0.08	0.14
Blackgram	1.61	3.13	5.36	6.48
Greengram	0.53	1.77	1.46	2.91
Redgram	0.10	0.02	0.10	0.01
Other pulses	0.15	0.31	0.32	0.04
Horsegram	0.99	0.60	0.03	0.06
All fodder	2.65	4.02	1.43	1.95
Sunflower	0.08	0.29	0.28	0.75
Groundnut	9.83	11.91	9.53	5.64

Sesamum	2.33	3.06	2.09	2.17
Other oilseeds	0.01	0.03	0.75	0.52
Cotton	5.99	3.00	2.31	2.07
Sugarcane	4.81	5.85	9.69	10.44
Others	20.7	14.18	9.41	5.67
Total cropped area	100.00	100.00	100.00	100.00

Source: Farm household survey data, Department of Agricultural Economics, TNAU, Coimbatore.

The paddy assumes important in cropping pattern for several reasons. They include assured market, price, home consumption requirement, and paddy straw is used for animal. More over growing paddy is considered as prestigious one in the local area. Though growing water scarcity is a serious problem, the farmers still show much inclination towards cultivation of paddy. The other crops assume important are pulses (black gram and green gram), commercial crops like cotton and sugarcane. In spite of various agricultural production problems such as labour and water scarcity, fluctuation in prices etc. the sugarcane cultivation attracted the farmers.

Contribution of crops in farm income

Farm households derive income from different sources such as crop production activities, animal husbandry, and off-farm activities. Of the total crop income, the crops like paddy, sugarcane, cotton, and groundnut contribute major share. It is interesting to note that the income share from sugarcane is increasing over the years but the share of income from other crops shows little downtrend (Table.3). Though, the food crops dominate cropping pattern in terms of area, the non-food crops, particularly the cash crops like sugarcane, cotton occupy major share in farm income.

Table.3. Share of income from different crops to total crop income

Crops	1980s	2000s
Paddy	60.9	54.5
Sorghum	1.3	2.7
Groundnut	4.6	3.3
Cotton	9.6	2.2
Sugarcane	23.6	37.3

Source: Household survey data, Department of Agricultural Economics, TNAU, Coimbatore

Sources of farm income

Although, crop production and allied activities like livestock, fisheries, and poultry are the major components of farming systems in most of the arid and semi-arid regions, they are yet to be well integrated. Integrating all these components not only helps in maximizing resource use efficiency but also achieving the developmental objectives of the farms. Hence, the interactions between different components of the farming system and contribution of each unit to the whole farming system are critical to understand.

Table.2. Percentage share of different sources of income among farmers in Tamil Nadu

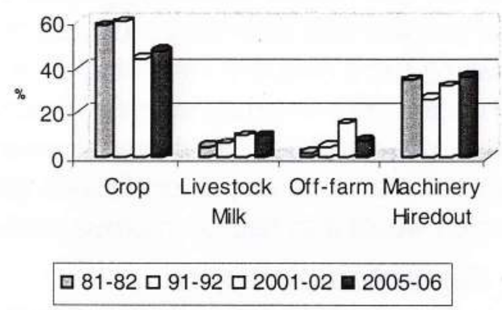
(Per cent)

Particulars	1971-72	1981-82	1991-92	2001-02	2005-06
Western region					
Crop	73.1	58.4	60.0	43.8	47.2
Livestock Milk	16.8	4.8	6.0	9.5	9.5
Hired Out	2.4	0.4	3.1	0.0	0.0
Off-farm	4.0	2.2	4.8	15.0	7.4
Machinery Hired out	3.8	34.2	26.0	31.7	35.9
Total	100.0	100.0	100.0	100.0	100.0
Southern region					
Crop	68.7	86.4	76.6	45.7	51.2
Livestock Milk	13.6	6.3	8.8	9.1	14.5
Hired out	5.0	2.3	5.1	2.7	3.2
Off-farm	12.8	5.0	5.6	13.1	12.6
Machinery Hired out	0.0	0.0	3.8	29.4	18.5
Total	100.0	100.0	100.0	100.0	100.0
Tamil Nadu state					
Crop	47.5	70.1	56.2	44.9	48.0
Livestock Milk	8.7	6.7	5.2	6.5	7.8
Hired out	1.3	1.0	2.4	1.7	1.0
Off-farm	5.4	3.9	4.1	10.3	7.6
Machinery Hired out	37.2	18.3	32.1	36.7	35.5
Total	100.0	100.0	100.0	100.0	100.0

Source: Household survey data, Department of Agricultural Economics, TNAU, Coimbatore.

Note: The Western zone comprises of the districts like Coimbatore, Erode, Namkkal, Salem. Dharmapuri and Krishnagiri. The Southern zone comprises of districts covering Sivagangai, Ramnad, Virudhunagar, Tutucorin, and Tirunelveli.

Fig.1. Percentage share of different sources of income in Western Zone Tamil Nadu



The trend in share of different sources of income to the total farm income shows interesting results. It is evidenced that the share of income from crop activities declines over the period across regions. However, the share of income from other enterprises particularly the animal husbandry is on increasing trend. It is interesting to note that within animal husbandry, the share of income from milk production is increasing where as the hiring out of bullocks is declining over the years. It lucidly implies that the use of bullock power in agricultural sector is declining and replaced by the machinery. Various agricultural production constraints such as labour scarcity, growing water scarcity coupled with ever increasing demand for milk products motivates farm households to diversify their farms by including allied sectors like animal husbandry. In this context, the integrated farming system plays a crucial role in livelihood security.

III. Integrated farming system

Integrated farming system meets spread out demand for food, income and diverse requirements of food grains, vegetables, milk, egg, meat etc., thereby improving the nutrition of small - scale farmers with limited resources. Integration of different agriculturally related enterprises with crops provides ways to recycle the products and by products of one component as input to another and reduce the cost of production and increase the total income of the farm.

1. Choice of crops and allied activities

Among the various factors responsible for determining the land use, resource endowments, market demand and agroclimatic conditions largely decide the nature of crops and allied activities. Besides, extent of mechanization, technological know-how of the farmers, infrastructural back-up and managerial skills are playing important role. The most important factor underlying the choice of enterprise is the basic desire of maximization of farm profit. National and local needs and priorities also have their role in deciding the composition of a farming system.

Integrated farming system focuses around a few selected, interdependent, interrelated and often inter-locking production systems. Normally, they are based on crops, livestock, and related subsidiary professions. This integrated nature involves the utilization of primary and secondary produces of one system as basic input of the other systems making them mutually integrated as one whole unit. This incidentally helps to reduce the dependence on procurement of inputs from open market, making the system sustainable on long term basis. For the development of sustainable farming system models, the concepts of intensification, diversification and value addition must be kept in view. The interaction would also help to improve productivity in various activities.

2. IFS - Expected outcome

i. Enhanced income

IFS provides opportunity to make use of the produce of one component as input on another component at the least cost. By reductions the cost of production, the profitability per rupee invested is enhanced by eliminating the interference of middleman in most of the inputs used.

Small ruminants like goats and sheep form an important economic and ecological niche in Asian mixed farming systems. Approximately, 60 per cent of goats and 20 per cent of sheep population are in Asia. The sale of goats contributes 30 per cent of the total farm income in India. The IFS research in Tamil Nadu provides interesting research results. In a small farm of 2 ha, goat component added an additional income of Rs. 12000/- with 6 goats. In North Western and deltaic districts. In the rainfed black soil areas in Southern Tamil Nadu tree legumes like *Leucaena leucocephala* (Subabul), *Acacia senegal* (Gum Arabic tree), *Prosophis cineraria* (Khejri) and perennial fodder grass with inclusion of six goats yielded an additional income of Rs.12,500 per year from a farm area of 1.6 ha. Reports state that for farm households, the average net income is shared between crops and livestock in the ratio of about 3:1.

Livestock keeping was more suited to small land holders to fetch additional income to the farm family. Reports show that, there was an increase in the return to the tune of 148 per cent due to the introduction of poultry cum dairy based integrated farming systems over cropping alone.

ii. Employment generation

Gainful employment is one of the major considerations for evolving any farming system. IFS under dryland with sorghum + cowpea, *Leucaena leucocephala* + *Cenchrus ciliaris* (Anjan grass), *Acacia senegal* + grasses with goat rearing generated an additional employment of 113 mandays ha^{-1} annually in a farm size of 1 ha. Maintenance of four milch cows with cropping could generate an additional employment of 274 man days as against cropping alone in Thanjavur delta in Tamil Nadu. Integration of crop - dairy - biogas - silviculture - spawn production could generate an additional employment of 562 man days than cropping alone under lift irrigated garden lands. Integration of duck cum fish culture and dairying could generate 396 and 702 man days, respectively, as against 252 man days with rice based cropping alone in Cauvery delta region of Tamil Nadu. Cropping with poultry + fish + mushroom generated the highest employment of 798 mandays. The allied enterprises added employment to the tune of 423 maydays providing opportunity for 1.16 family members to be employed per day round the year.

IFS study at Bhubaneshwar for a period of two years comprising of field and horticultural crops, fishery, poultry, duckery, apiary, mushroom, dairy and agro-forestry generated an additional employment of 573 man days on a small piece of land of 1.25 ha. At Kasargode, one hectare of coconut gardening required 150 man days and it increased to 1000 man days on introduction of dairy based integrated farming. Cropping alone generated 400 man days as against 904 in integrated farming systems with six buffalo. Cattle and buffalo rearing involved intensive use of family labour and offered significant employment opportunity for small and marginal farmers. A herd of 200 goats under integrated farming systems provided full time employment for two persons throughout the year. Labour utilization was found to increase by 182 per cent in integrated farming systems by the introduction of 270 poultry birds in a crop cum poultry enterprise. Cropping alone generated 245 man days and integrated farming systems with sericulture in one hectare generated 598 man days in a year.

iii. Nutrient recycling

Replenishment of soil fertility status through substantial improvement in the post harvest available NPK nutrients could be achieved even with higher removal of nutrients through crop uptake by the application of recycled or composted pigeon and poultry manure combined with inorganic fertilizer. Application of 50 per cent nitrogen through fertilizer and 50 per cent through goat manure enhanced the soil fertility status and provided better opportunity for recycling of manure to the crops. Continuous dairy based farming system increases organic, carbon and available status of nutrients.

iv. Alternate land use options

IFS provides alternate land use systems which are more appropriate in areas where subsistence farming is practiced in fragile ecosystems and it possess more potentiality and flexibility in land use than the traditional crop production systems.

a) Agrisilvicultural system - Lesser risk

Agroforestry is an integrated self sustained land management system, which involves woody perennials with agricultural crops including pasture/livestock simultaneously or sequentially on the same unit of land and meeting ecological as well as socio economic needs of the people. Due to low initial cost and ensured seasonal income through intercropping and supply of different kinds of raw materials to support cottage industries, tree farming could certainly offset the risky farming especially under dryland conditions.

b) Agri horticultural system - Higher income

Fruit based cropping systems are not only known for their economic viability but also generate employments and give assurance against crop failure during drought years. Maize, sorghum and cowpea are compatible with trees like *Psisdium gujava, Eugenia jamolana* and *Annona squamosa.* Under rainfed conditions in alfisol, agrihorticulture systems give the highest benefit cost ratio compared to annual cropping.

c) Silvi/Hortipastural system - Improved sustainability

Horticulture is one of the agroforestry systems which involve integration of fruit trees with pasture. *Cenchrus ciliaris* and *Cenchrus glaucus* are grasses and *Prosopis cineraria* and *Acacia senegal* are the trees suited for the system. *Stylo* and *Cenchrus* are compatible fodder crops with guava, custard apple and mango. In Southern zone of Tamil Nadu, the gross income and B: C ratio obtained from sorghum + tamarind, sorghum + neem, blackgram + neem, blackgram + tamarind were found sustainable.

v. IFS - solution to energy and fodder crisis

a. Solve energy crisis

It is expected that the entire world is going to suffer for want of fossil fuel from 2030 AD. So it becomes inevitable to identify an alternative source to solve our energy crisis within a span of 3 to 4 decades. In IFS, by way of effective recycling techniques the organic wastes available in the system can be utilized to generate biogas. Though this may not be a source for complete supplementation, to certain extent of the energy crisis can be solved.

b. Solve fodder crisis

In IFS, each and every piece of land area is effectively utilized. Growing of perennial fodder trees in the borders and water courses only helps in supplementing legume fodder but also enriches soil nutrients by fixing the atmospheric nitrogen. In the cropped land, IFS envisages intensification of cropping by including legume fodder like cowpea either as second tier or as third tier in the system. These practices relieve the crisis of non-availability of quality fodder to the animal component linked.

c. Solve fuel and timber crisis

The national demand of fuel wood in 2020 AD is 400 million m^3, whereas the current production is only 20 million m^3. Similarly, the requirement of industrial wood in 2020 AD is 64.4 million m^3 and the current production level is just 11 million m^3. The present level of production should be increased to twenty folds in case of fuel wood and six folds in industrial wood. This could be possible to certain extent by afforestation programme in the shrub jungles and sparse forest areas. In IFS by linking agro-forestry appropriately, the production level of fuel wood and industrial wood can be enhanced without detrimental effect on crop activity in the field level.

d. Avoid degradation of forests

There is a vast gap between the demand and production level as far as fuel wood and timber are concerned. This naturally induce the users to encroach on the forest area nearby illegally to bridge the gap. Right now our forest area is lesser (22%) than the prescribed norm off 33%, to the geographical area. Even the forest area at present has more than 2/3rd sparse vegetation. By linking Agro-forestry in IFS, the degradation of forest area could be minimized to certain extent by supplementation of fuel and timber wood.

VI. Experimental results

(i) Tamil Nadu

a) Wetland ecosystem

Integration of crop with fish, poultry, pigeon and goat resulted in higher productivity than cropping alone under lowland ecosystmes. Crop + fish + goat integration recorded higher rice grain equivalent yield of 37679 kg/ha than other systems. Similarly, as an individual livestock component, the goat unit (20 + 1) gave the highest productivity of 8818 kg. This system provides 11.0 t tones of valuable manure apart from supplementing the feed requirement of 400 numbers of fish. While assessing the feasibility of rearing fish by using poultry, pigeon and goat droppings as feed, the fish fed with poultry droppings resulted in higher fish yield (825 kg / 0.04 ha ponded water).

The highest net return of Rs.1,31,118 and per day return of Rs.511 ha^{-1} were obtained by integrating goat + fish + rice based cropping applied with recycled fish pond silt enriched with goat droppings (Table 4). The employment opportunity was also increased to 576 man days ha^{-1} $year^{-1}$ by integrating fish + goat in the cropping as against cropping alone (369 man days ha^{-1} $year^{-1}$).

The poultry, pigeon and goat droppings were utilized as feed for fishes and at the end of a year after the fish harvest, about 4500 kg of pond silt were collected. The pond silt was utilized as organic sources to supply sufficient quantity of nutrients to the crops (Jayanthi, 2002). The additional nutrients gained by recycling were the highest with poultry manure with 65.7, 28.4 and 25.0 kg N, P_2O_5 and K_2O, respectively.

The residue addition and nutrients potential were higher in crop + fish + poultry / pigeon / goat than cropping alone (Table 4). The residue addition was three fold increase in integrated farming system than cropping alone. The nutrient potential ranged from 78-186 kg N, 28 - 115 kg P_2O_5 and 52 - 89 kg K_2O, in crop + fish based farming systems.

Integration of allied enterprises with cropping increased the nutritive value of the products. Cropping with pigeon + fish + mushroom found to have the highest protein of 1963 kg. Integration of cropping with fish+mushroom and pigeon / poultry could result in 31 / 52 per cent higher protein yield than cropping alone. Highest fat yield of 1355 kg was recorded by the integration of cropping with poultry + fish + mushroom which was 139 per cent more than that of cropping alone. The above system provided 17447 kcal of energy day^{-1} as against 11786 kcal day^{-1} from cropping alone with gain of 5660 kcal day^{1}.

Table-4: Productivity, profitability employment generation and residue addition integrated farming system (wetland ecosystem)

Farming Systems (one ha)	System productivity (kg ha^{-1})	Total Cost (Rs ha^{-1})	Net Returns (Rs ha^{-1})	B:C Ratio	Employment generation (man days ha^{-1} year^{-1})	Residue addition (t ha^{-1})	Nutrient potential (kg ha^{-1} year^{-1})		
							N	P_2O_5	K_2O
Cropping alone	12995	27822	37153	2.43	369	3.8	19	7.6	19.0
Cropping + Fish + Poultry	29609	48303	97731	3.02	515	9.5	186.2	96.9	68.4
Cropping + Fish + Pigeon	29173	47090	98778	3.06	515	9.3	78.1	27.9	52.1
Cropping + Fish + Goat	37679	55549	131118	3.36	576	18.5	129.5	114.7	88.8

(Jayanthi, 2002)

In lowlying wetlands, the most profitable farming system was rice-rice-azolla-calotropics + fish farming. The soil fertility status indicated that in general there was an increase in the available nutrient after completion of cycle (Table 5). Even after heavy depletion, through crop removal, the nutrients status could be replenished by the addition of organic residues. A gain of 24 kg N ha^{-1} could be obtained with IFS as against rice alone. This might be due to degradation of Azolla, fish manure and fish feed under these systems.

Table 5. Yield, economics and nutrient of different farming system

System	Paddy grain yield (kg ha^{-1})	Fish yield (kg ha^{-1})	Net return (Rs. ha^{-1})	Initial N (kg ha^{-1})	Crop removal (kg ha^{-1})	Available (N kg ha^{-1})
Rice - Rice	10099	-	15299	227	82	219
Rice - Rice-azolla calotropis + fish	10125	173	17488	221	93	251

(Balusamy, 1994)

Results of the experiment conducted in Malaysia revealed that the productivity and net income of the components were higher with the combination of pig-duck-poultry-fish integrated farming system. Three tier system of poultry-pig-fish combinations with 42 pigs and 60 laying hens were be able to produce 4000 kg of fish, 8000 kg of pig meat and 15330 eggs $year^{-1}$ in an area of 2400 m^2.

b) Irrigated upland ecosystem

Under irrigated upland ecosystem, three jersey cross bred milch cows with 2 calves along with cropping resulted in effective recycling of farm and animal waste. Bio-gas unit of 2 m^3 capacity for the production of fuel, light and enriched manure. Sixty kg of cow dung expected out of 5 animals is sufficient enough to produce 2 m^3 of gas everyday which is equivalent to 1.5 litres kerosene. Two hundred numbers of subabul trees were planted all along the boundary of the field for fodder and timber production. The results of the study revealed that the entire system produced a net income of Rs.20,702 ha^{-1} $year^{-1}$ during 1990 (Table 6). This system also facilitated effective recycling of farm and animal waste, improved farm employment opportunities and continuous flow of income to farm throughout the year (Rangasamy, 2000). The allied enterprises generated additional employment of 620 mandays providing opportunity for 1.28 family members to be employed round the year.

By recycling, some of the weed seeds present in the raw cow dung also get killed during digestion process, thus improving the quality of the slurry over its raw material used *viz.,* cow dung. Recycling of cow dung lead to the production of 730 m^3 of biogas with the possibility of enhancing the nutrient value of NPK to the tune of 44.5 kg, 65.9 kg and 28 kg respectively, in a year. Trace elements like Fe, Mn, Zn and Cu are also present in an enhanced level over FYM.

Table 6. Economics and employment generation in irrigated upland farming systems

System IFS with	Gross income Rs/ha	Expenditure Rs/ha	Net income Rs/ha	Employment (man days/ha/yr)	Residue addition (t ha^{-1})	Nutrient potential (kg ha^{-1} year^{-1})		
						N	P	K
Crop + Dairy (5) + Biogas (2 m^3) + Fodder trees (200 Nos.)	74948	40369	34579	1250	11.0	157.3	133.1	144.4
Cropping	32220	18343	13877	630	6.25	18.8	15.6	21.9
Additional benefit	42728	22026	20702	620	4.75	138.5	117.5	122.5

(Rangasamy, 2000)

c) Dryland ecosystem

To overcome complete failure due to vagaries of monsoons in the rainfed areas through traditional crop activity being practiced, integrating different enterprises and utilising the biomass built up have been identified as a successful venture to give regular income to the rainfed farmers. There is a good scope for getting required biomass even with the erratic seasonal rainfall, by integrating allied enterprises *viz.*, goat, buffalo, pigeon, rabbit, etc. The outcome of these enterprises will be an alternate source for protein, carbohydrate, fat, minerals, vitamins and energy. Drought tolerant perennial forest wood /timber value trees can also be raised utilising the rainfall received round the year and can be a good source for valuable fuel wood or timber after some years.

In dry land situations, integrating crop with pigeon, goat, buffalo, agroforestry and farm pond resulted in higher system productivity of 12,387 kg ha^{-1}, net income of Rs. 21,818 ha^{-1} and generated employment of 163 man days ha^{-1} yr^{-1}. (Esther Shekinah, 2002).

Table-7: Productivity, economics, residue addition and employment generation of the dryland farming system

Farming systems	System productivity (kg ha^{-1})	Net return (Rs. ha^{-1})	Employment generation (man days)	Residue addition (kg ha^{-1})	Nutrient potential (kg ha^{-1} year^{-1})		
					N	P	K
Conventional cropping system with crop alone	1270	1,167	30	1,688	10.1	3.2	18.5
Crop + pigeon + goat + agroforestry + farm pond	4723	9,304	113	3,855	41.5	17.5	36.9
Crop + pigeon + buffalo+ agroforestry + farm pond	10994	22,670	141	10,383	84.1	34.8	65.9
Crop + pigeon + goat + buffalo + agroforestry + farm pond	12387	21,818	163	11,583	105.9	46.2	76.9

(Esther Shekinah, 2002)

Highest residue addition (11,583 kg year^{-1}) was possible with Crop + Pigeon + Goat + Buffalo + Agroforestry + Farm pond with a nutrient value of 105.9, 46.2 and 76.9 kg NPK respectively.

The results indicated that enterprise combination in a farming system resulted in higher nutritive output rather than cropping alone. The superiority of the system where crop supplied with composted buffalo manure was integrated with pigeon, goat, buffalo, agroforestry, farm pond in terms of carbohydrate, protein and fat. Two buffaloes with milk yield of 3163 liters year^{-1} provided 1878 kg of carbohydrate, 1614 kg of protein and 2440 kg of fat yield year^{-1}.

d) Farmer participatory IFS

Experimental results on farming system conducted for irrigated upland in farmers fields of Coimbatore district, Tamil Nadu revealed that integration of improved cropping, dairy, goat, guinea fowl and vermicompost resulted in higher productivity, profitability and employment generation than traditional farming system and also it provides scope for efficient recycling of animal and crop residues as vermicompost and compost to the crop activities.

Integrated farming system gave the maximum net return of Rs.99,670 ac^{-1} which was 26.4 higher than the traditional farming system. Integrated farming system was able to generate 235 man days acre^{-1} which was higher than the traditional farming system (105 man days acre^{-1}) through integrated farming organic residues added was 7.83 tones ha^{-1}. Through recycling of crop residues and animal manure from IFS components about 5.31 tonnes of compost was obtained with 1.59 tonnes as vermicompost and 3.72 tonnes as biocompost. This could able to supply 26.0, 22.3, and 26.0 kg N P K to field and fodder crops through biocompost and 39.4,10.5 and 18.0 kg NPK to vegetable crops as vermicompost in acre land area. (Jayanthi, 2007).

Income measures

Efforts have also been made to assess the profitability of integrated farming systems. It is evidenced that the integrated farming system resulted in relatively higher returns when compared to the conventional practice followed by farmers. For instance, the integrated farming system in Location 1 yields Rs. 98270 as net income when compared to Rs. 28600 in traditional farming system (Table.8).

Table. 8. Comparison of income measures

Location	Particulars	Gross return (Rs)	Total cost (Rs.)	Net income (Rs.)	GVCR*	NVCR**
1	Traditional farming system (Crops + livestock)	49700	19100	28600	2.60	1.49
	Integrated Farming system (Crops+Livestock+Goat+Poultry)	127049	39205	98270	3.24	2.51
2	Traditional farming system (Crops + livestock)	40700	16800	23900	2.42	1.42
	Integrated Farming system (Crops+Livestock+Goat+Poultry)	128960	29751	99209	4.33	3.33
3	Traditional farming system (Crops + livestock)	44000	17500	26500	2.51	1.5
	Integrated Farming system (Crops+Livestock+Goat+Poultry)	131175	39771	101531	3.29	2.56

* * Indicates the ratio of gross value of output to the cost of cultivation/cost incurred in the whole system;

** Is the ratio of net income to the total cost incurred in the whole system.

The returns per rupee of investment, as evidenced from the ratio of gross value of output to total cost (GVCR) and ratio of net value of the products to total cost (NVCR), indicate that the ability of integrated farming system to generate more returns when compared to the traditional system. Though huge initial investment is made in the integrated farming system, the system is able to generate more income in a sustained manner. Moreover, as the resources available to farmers are limited, the profitability in terms of net income could be considered as viable indicator. Thus, one can speculate that the integrated farming system results in higher returns and upscaling the IFS across production environments will help enhance farm income in a sustainable manner.

IFS Impact on Farm Income

The integrated farming system plays critical role in achieving better interaction among the various components of the system. This helps in achieving better yield and hence increases in farm income. To better understand the influence of IFS on farm income, a multiple regression analysis was performed using the data collected in western zone of Tamil Nadu.

The gross farm income is expected to influence by farm size in hectares (FSIZE), human labour used in man days (LABOUR), fertilizer in kgs. (FERTILIZER), educational level of the head of the household (EDUCATION), experience of the farmers in years (EXPERIENCE) and the type of farming system (IFS). The farm size here included mainly for controlling the scale effect. The variable IFS is used here as a dummy variable assumes value 1 if integrated farming system is followed by the farmer, 0, otherwise.

The estimates of the farm income model show that the gross farm income of the farm is found to be significantly influenced by size of the farm, human labour used in the farm, fertilizers, educational level of the head of the farm household, and the inclusion of integrated farming system. The inclusion of integrated farming system significantly influences the gross farm income. It implies that inclusion of additional component such as goat, poultry and more milch animals in the farm significantly increases farm income.

Table.9. Estimated results of factors influencing farm income

Variables	Dependent variable : Gross Farm Income (Rs.)
Constant	7.5865 (20.683)
FSIZE	0.2062 *** (4.035)
LABOUR	0.4893 *** (9.672)
FERTILIZER	0.1068 *** (3.027)
EDUCATION	0.1193 ** (2.014)
EXPERIENCE	0.0558 (0.591)
IFS	0.3351 *** (4.092)
Adjusted R-squared	0.84
F-Statistics	119.91 ***
MODEL	OLS
Number of observations	133

* Significance at 10 % level; ** Significance at 5 % level; *** Significance at 1 % level;

Figures in parentheses indicate estimated 't' ratios

(ii) Other parts of India

(a) Uttar Pradesh

Farming system models were developed through integration of livestock, poultry and fishery components with the crop production, which established mutual beneficial relationship facilitating effective recycling of residues within the system. An area of 0.5 ha area was allocated to rice - pea - okra sequence and in small area of the farm, the fodder sequence involving sorghum - berseem - maize was taken to meet the green fodder requirement of dairy throughout the year and hence these two cropping sequences were integrated with different farming system enterprises like dairy, poultry and fishery to find out the best combination of farming system components. The farming system component consisting of crop +dairy + poultry + fishery resulted in highest system productivity (117846 kg ha^{-1}) and net income of Rs. 4,07,737 ha^{-1} than crop + dairy, crop + poultry, crop + fish, crop + dairy + poultry, crop + dairy + fish, crop + fish + poultry (Kalyan Singh *et al.*, 2004).

Table-10: Economics of different farming system models for NE plain zone of Eastern U.P.

System	Cost of cultivation/ production (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)
Crop + Dairy + Poultry + Fishery	3,07,628	7,15,366	4,07,737
Crop + Dairy + Poultry	3,01,905	7,03,731	4,01,826
Crop + Dairy + Fishery	2,76,292	6,50,084	3,73,792

(Kalyan Singh et al., 2004)

(b) Maharastra

A field experiment was conducted at Parbhani for three years to compare comparative productivity and profitability of sole cropping, cropping + one cross bred cow and cropping + one cross bred cow + sericulture. The land area allotted to each treatment was 0.40 ha. Mulberry was planted on 0.10 ha. The three years results indicated that maximum annual net income was obtained from cropping + dairy. However, maximum employment was generated in cropping + dairy + sericulture.

(c) North East hill region

The hilly terrain of North East hill region is suitable for sustainable multi enterprise system. Notable land use systems prevailed in this area under watershed based farming include: Agri-pasture, agri - horti - silvi - pasture and livestock based enterprises. The Tripura centre of this region developed a multi enterprise model combining agriculture with horticulture, forestry and livestock rearing. The model is developed for one ha land. The enterprises taken are : cereal crops, pulses, oilseeds, horticultural crops such as mango and pineapple, vegetable crops and livestock components of duckery, piggery and fishery in the water harvesting structures. The economic analysis indicates that the multi enterprise system is nearly 5 times more profitable than traditional mono crop rainfed rice cultivation which gave maximum productivity of 10 q ha^{-1} of rice (Rs.5000-6000 ha^{-1} $year^{-1}$). This system improved the profitability of about 121150 Rs.$Farm^{-1}$ by inclusion of export generating industrial crops like vegetables.

Table-11: Annual income under hi tech agriculture from different integrated farming systems along with the different sub systems of farmers in hills (Rs/ Farm)

Particulars	Food grain based farming system	Dairy based farming system	Vegetable based farming system	Horti based farming system	Overall average
Field crops including food grains and oilseeds and other crops	28305 (25.95)	9555 (8.15)	16382 (6.40)	13485 (6.51)	17022 (9.74)
Vegetables including potato	13000 (11.47)	5670 (4.85)	121150 (47.35)	7685 (3.61)	36876 (21.09)
Fruits and Farm Forestry	10560 (9.32)	7890 (6.74)	7845 (4.06)	91250 (42.91)	29386 (16.81)
Dairying: Sale of milk, other products and animals	10440 (9.21)	42840 (36.58)	14440 (5.65)	12425 (5.85)	20036 (11.46)
Sheep, Goats, Sericulture, Honey bees	1440 (1.26)	1850 (1.58)	1250 (0.48)	1170 (0.55)	1428 (0.82)
Rabbitry, Mushrooms, Fishery	11450 (10.09)	15700 (13.41)	10650 (4.16)	9500 (4.46)	11825 (6.77)
Size of holdings (ha)	1.32	0.68	1.18	2.14	1.33

(Figures in parenthesis show percentages of total income)

(Thakur, 1999)

In general, farmers follow a mixed cropping type of farming system. However, depending upon their major source of income, four farming systems namely food grain based, dairy based, vegetable based and horticulture based farming systems were taken for on farm study.19

he average annual gross income of farmers which was only Rs. 57651 from their existing farming system primarily based on crops has gone upto Rs. 1.74 lakhs or so with integrated farming system with improved cropping systems. The vegetable based farming system gave the highest income of Rs.2.55 lakhs followed by the horticulture, dairy and food grain based farming systems (Thakur, 1999).

Conclusion

Farming system models at different situation could enhance the productivity of the farm as whole, improve the profitability in terms of additional net return and continuous flow of income to the farmer and sustain the soil health through residue addition and improve the major and micro nutrient supply effective recycling of crop residues and livestock waste results in environmentally safe disposal. The enterprise linkage provides good opportunity for regular and gainful on-farm employment for farm family members with equi-temporal distribution. This also helps for nutrition security through optimized carbohydrate, protein, fat and energy supply by integrating allied enterprises.

However, there are certain constraints like heavy investment in the initial stage, especially for the procurement of enterprises, involvement of multi-disciplinary activities likes Animal Husbandry, Fishery, Sericulture, Horticulture, Forestry, Agricultural Engineering etc, non-availability of improved cultivars/varieties/breeds of livestock at farms site, lack of know-how especially on the constituents of feed and the possibility of supplementing from their own produces with cheaper rate and lack of marketing for the produces from different enterprises at village level are anticipated in the progress of this technology.

Views of Panalist:

Dr. P.G. Chengappa, Vice Chancellor, UAS, Bangalore expressed his views presenting a paper on

Integrated Framing System Approach For Livelihood Security

Introduction

In India, as in many other parts of the semi arid regions of the world, more than 75 percent of the area under agriculture is rain fed and is inevitably linked to the vagaries of the monsoon and the fact that more than seventy percent of the land holdings in the country belong to small and marginal category further aggravating the problems in production. Though the dry land farming is predominant, it has become a neglected sector because of the high risk and the meager profit it generates. However, the compelling need to provide increased food , fuel, fodder, and fiber to the farm family and absence of alternative source of income have resulted in virtual mining of these land resources. Dry land agriculture attracts poor investment and lacks institutional support. The natural resources like land, water and forest are highly degraded. The direct result of this disturbing trend is soil erosion, nutrient loss, diminished stream flow and water scarcity.

These in turn have led to decline in crop yields and food security among the dry farming households.

Scientists have the responsibility to evolve strategies to make small and marginal holdings viable. The development efforts hitherto to address the problems of vulnerable group was largely technology and input focused. Though several technologies were developed for the benefit of rural population, their impact did not trickle down due to poor multiplier effects. The technologies introduced were resource intensive, which further created pressure on the marginal resource, especially, in dry land areas. Further, the technologies were disseminated in an adhoc or piecemeal approach without considering linkages with other institutions including market and capacity building at different levels. Thus, development efforts could not adequately get internalized with the farming systems, the mainstay for sustainable livelihood.

The technologies can realize full potential when they are implemented in a holistic manner involving multi-level and multi- institutional support system offering a basket of technologies with backward and forward linkages to the target groups. The process of technology dissemination requires a mechanism to make system viable and sustainable

The strategies that aim at Sustainable Rural Livelihood Security (SRLS) should lay emphasis on conserving and improving the existing natural resource base and evolve appropriate farming systems that could bring in additional income to farming community.

Integrated Farming System

Integrated farming System (IFS) approach as a bio-physical and socio-economic capsule has immense potential to address instability of income, food and nutritional insecurity, unemployment, vulnerability and poverty of farmers' as well as landless laborers. The urgency for addressing issues of livelihood security mainstreaming rural poor to the benefits of production technologies and development process in an integrated manner needs no emphasis. This calls for establishing synergy and complimentary to both at production system levels and beyond production, farm activities to non-farm activities.

Towards this endeavor the strategies envisage *inter alia*, soil and moisture conservation, groundwater recharge, change in farming system with new varieties of crops based on change in resource characteristics in response to farmers' needs and expectations; promotion of Good Agricultural Practice (GAP), validation of local knowledge, blend of new innovations /technologies, promotion of local resource use with minimal dependence on external inputs, linkage of farmers' produce to market, developing products for niche markets; developing process for value addition, promotion of cost competitiveness; mainstreaming women groups to path ways of economic and social progress; empowering community for risk management. The technologies that promote self-reliance and decision-making about use of local resources and product are crucial in sustainable systems.

The IFS has rich potential to contribute to sustainable rural livelihoods as the key bio-physical and socio-economic capsule to address the challenges faced by farmers and landless agricultural labourers. Identification, validation on pilot basis of IFS modules with reinforcement from institutions and markets facilitating up-scaling, outreach for economic security and empowerment of stakeholders, focusing on women, vulnerable groups holds the key for future rural development.

University of Agricultural Sciences, Bangalore demonstrated an one acre IFS model in Bavikere, Tarikere taluk of Chikmagalore district falling in Southern Transitional agro-climatic zone of Karnataka on a mini micro-watershed basis by integrating agriculture, horticulture, agro-forestry crops, silvi-pasture, green manure crops, hedge plants, trees, fodder grass, kitchen garden, apiary, dairy for milk and manure, cattle shed, compost pits, fish pond, poultry, agave for hedge and fibre, casurina and silver oak for fuel and timber besides rainwater harvesting from the farm and building. This model demonstrated the synergies realized by integrating food, fodder, fruits, fibre, flowers, fuel and fish (7Fs) components for meeting nutritional and economic security on a sustainable basis. The UAS Bangalore has developed 52 typical such IFS models suiting various agro-climatic regions in the State.

The model is gaining popularity among farmers. As a consequence the State Watershed Department has come forward to implement this model in all the 10 Agro-climatic Zones of the State by bringing necessary changes in the model suited to different zones. Adoption of such a model will go long way in ensuring livelihood security , especially of small and marginal farmers who form major part of rural households who often are below poverty line.

The SAUs and ICAR institutions have to come together in evolving location specific IFS models for each agro-climatic zone, keeping in view the local resources, food habits and type of market integration that can be thought off to ensure sustainable income to farmers.

Repportears:

- Dr. A.K. Singh,
- Dr. Chattopadhyay,
- Dr. Atul Kumar

TECHNICAL SESSION-V

Export oriented agricultural production with context to WTO, GATT opportunities strategies and action plan.

Chairman: Dr. Sushil Kumar, Director, NDRI, Karnal

Co-Chairman: Dr. Basant Ram, Vice Chancellor, NDUA&T, Kumarganj

Invited Paper:

Enhancing Market Orientation of Livestock Production system: Opportunities and Challenges

Sushil Kumar* and Smita Sirohi**

A revolution is taking place in global agriculture that has profound implications for our health, livelihoods and environment. Population growth, urbanization and income growth in developing countries are fueling a massive global increase in demand for food from animal origin. The combined per capita consumption of meat, eggs and milk in developing countries grew by about 50 percent from the early 1970s to the early 1990s. As income rise and cities swell, people in the developing world are diversifying their diets to include a variety of livestock products- meat, eggs, dairy products, etc. The ensuing "livestock revolution" in world agriculture in the next 20 years or so could provide income growth opportunities for livestock producers.

In India, livestock is an integral part of farming system. Livestock sector is adding value to the tune of Rs 130 thousand crore (4.36%) to the country's GDP. This sub-sector is an integral part of the agricultural sector in the country, contributing over one- fourth (27%) to the agricultural GDP and providing employment to 18 million people in principal or subsidiary status. The annual growth rate of livestock GDP has been 4.4% in the past, which is higher than growth rate of agriculture GDP. Moreover, while the share of agriculture GDP in decreasing in total GDP, the share of livestock sector in agriculture GDP is increasing, thanks to the wide spread demand and enhanced production especially that of milk accounting for 67% of the value of output from livestock sector. The second major product of livestock sector is the meat and meat products counting for 18% of the value of output. The quantum jump in milk production during the last ten years has significantly increased the share of this group of output in the total livestock production.

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This is the sector where the poor contribute to growth directly instead of getting the trickle down benefit from growth generated elsewhere. The overall growth rate in livestock sector is steady and is around 4-5% and this has been achieved despite the fact that investment in this sector was not substantial. The ownership of the livestock is more evenly distributed as compared to land, with landless labourers and marginal farmers owning bulk of livestock. The progress in the sector results in balanced development of the rural economy particularly in reducing the poverty amongst the weaker sections. The rural women play a significant role in animal husbandry and are directly involved in most of the operations relating to feeding, breeding, management and health-care of the livestock.

This paper presents the broad trends in production, domestic consumption and exports of livestock products, particularly dairy exports to Asian countries and flags the critical issues that merit attention for tapping the emerging growth opportunities in livestock sector.

Recent trends in livestock Sector

Production:

Milk production increased from 22 million tones in early 70s to the present level of 100 million tones, earning India the distinction of being the world's top most milk producing nation for past several years. The sustained growth in milk heralded the country into an era of self sufficiency towards late 1990s, and reduced dependence on imports.

Like milk, growth in meat production too has been robust. Meat output grew at an annual rate of 4.9 percent during 1980s and 4.2% since 1991. In early 1980s, small ruminants were the major suppliers (44%) of meat, followed by large ruminants (25%) and poultry (19%). In the recent years, poultry industry has witnessed spectacular growth performance and poultry meat now accounts for over one third of the total meat production. India is the fifth largest producer of eggs and eighth largest producer of poultry broiler in the world. The output of eggs is increasing at the rate of 4-8 percent and broiler at 8-10 percent per annum.

Domestic Consumption:

The foods of animal origin on an average, account for about 11-12 per cent of the total consumption expenditure. Milk is the most preferred item, claiming 70% of the expenditure on livestock based foods. Meat comes next with a share of 17 per cent, followed by fish and eggs. Livestock food products contribute 18.4% to the total protein available per person. Since the beginning of the previous decade, while the per capita consumption of foodgrains has almost stagnated, consumption of animal products, fruits and vegetables has risen very fast in India. Total consumption of different livestock products has increased at a growth rate ranging from 2.22% per annum for Mutton & Goat meat to 9.66% per annum for Poultry meat. Eggs consumption recorded the second highest growth rate (6.13%) and milk consumption increased by 4.44% during 1970-2003. In quantity terms, absolute terms, the per capita consumption increased from 43 kg to 80 kg for milk, 2.4 kg to 3.1 kg. for meat, 2.4 kg. to 3.5 kg. for fish and the number of eggs consumed rose from 9.2 to 19.5. The projections till 2020 indicate further considerable increase in domestic demand for these products.

Trade of livestock and livestock products:

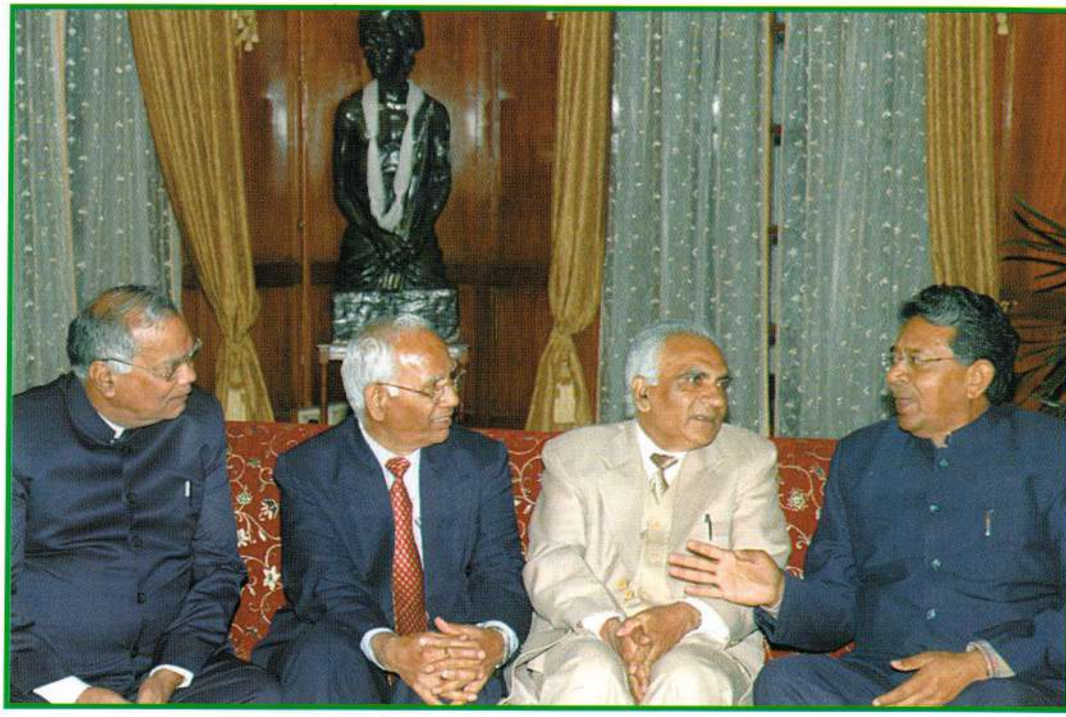
Meat and meat preparations have constituted the major item in India's export basket for the past four decades. The exports of this product group have shown considerable and consistent increase in terms of both, absolute value of exports and share in total exports of livestock products. However, India's share in the world exports of meat has stagnated at around 0.6% implying that the country has been able to capture only a miniscule portion of the world meat market.

In the post liberalization period, dairy exports are somewhat gaining ground but as the world dairy markets continue to be highly protected, the share of dairy exports in total exports of livestock products is less than one seventh. After the implementation of WTO, the exports of eggs from India (in value terms) increased more than fifteen-fold from an average of $3.94 million during 1992-94 to $61.96 million during 2004-06, as eggs are subject to less barriers and domestic industry is price competitive in eggs.

The import basket of livestock products in India mainly comprises of dairy products, and these products have a lion share in the total imports of livestock products from 1960 till 2002. However, after the 90's due to opening up of the domestic dairy industry to private players and resulting increase in production of dairy products, the value of dairy imports has declined substantially, particularly in the current deacde. All the other product groups do not have a significant share in the imports. From the trade trends across broad product group categories it is discernible that some changes have occurred in the export-import basket of Indian livestock products after the 1990s.

Volume and Direction of Exports:

The average exports of meat and edible offals, the major item in India's export of livestock products, which was about 137 thousand tones in 1993/94-1995/96, has increased very sharply to about 303 thousand tones in 2002/03-2003/04. Meat of bovine animals, particularly buffaloes comprise bulk of meat exports from India. The exports of poultry meat which is subject to less trade barriers after implementation of WTO has also increased very rapidly from 1998/99 onwards after almost being eliminated from the export basket in 1996/97. The declining protection of poultry meat trade coupled with the fall in demand



Dinner Hosted by His Excellency at Governor's House
During 32nd IAUA Vice Chancellor's Annual Convention

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of beef & beef products due to bovine spongiform encephalopathy (BSE) fear, after discovery of several cases after September 2001, increased the demand of poultry meat. Indian exports increased by 73.1% in 2000/01-01/02 over the average of previous two years (i.e. from 16.9 to 62.8 tones) and further by 96.6% (1871.6 tones) in the next one and a half year (till September 2003). As for the exports of ovine and swine meat, it hardly seems to have got any impetus from the trade liberalization.

The meat exports across countries show some interesting results. Although South East Asia (Malaysia and Philippines) and the Gulf countries continue to be the major destination of our meat exports, yet the continuous decline in the share of top 10 countries from 92.37% in 1996/97-1997/98 to 81.32% in 2003/03-2003/04 indicates emergence of new markets of our product. For instance, Georgia which is now among the top 10 meat importing country from India did not import meat from us from 1996/97 to 1999/00. Also, Canada and Cyprus which had highly protected domestic meat industries have also imported meat from India in recent years.

Along with meat and edible meat offals, the exports of meat preparations have also shown buoyancy in the last couple of years, although the volume of exports was only 671.13, tonnes in 2002-03. The bulk of exports in this product group are for poultry and bovine meat preparations and our main markets are Malaysia, Hong Kong, UAE, Bahrain and Seychelles.

The export of dairy products which was on an average about 5 thousand tones during 1993/94 -1995/96, increased to 14.5 thousand tones in 2001/02-03/04, but during this period the trade has been highly volatile, registering sharp decline in some years and increase in others. Large fluctuations in volume of exports from one year to another makes it difficult to trace out any pattern regarding the impact of global trade liberalization on Indian exports of dairy products. Nevertheless, some new products have entered in the export basket, like, milk & cream of low fat content (<1%), curdled milk & cream, kephir, fermented & other acidified milk and whey. Also, the exports of cheese, specially fresh and processed cheese, have increased quite substantially in the recent years. The Indian dairy products mainly find market in neighboring countries of Bangladesh and Nepal and the Gulf countries. But recent years have witnessed that our whey and products constituting of natural milk constituents have been able to make inroads in Korea, Japan, Germany and Canada. The USA is also importing few cheese products from India.

India is the main competitor to the USA in international egg market along China and the EU. In 2002, the ban on U.S. poultry products by Ukraine, Moldova and Russia because of use of antibiotics, outbreak of low-pathogenic strains of Avian Influenza in several provinces of USA and EU (mainly Netherlands) resulted in lower exports of eggs from these countries to the advantage of India. The top 10 destination of eggs during

2002-04 include several European countries (Denmark, Belgium, Germany and Austria) and Japan besides the Gulf countries (UAE, Oman, Kuwait, Saudi Arabia and Qatar).

Volume and Direction of Imports:

On the import side, the impact of removal of Quantitative restrictions (QRs) and lowering of tariff barriers manifests itself in the import of poultry and dairy products. Although meat & edible offals and meat preparations has very small share in our import basket, the import of poultry meat and its preparations has increased in the last four years. Due to India's compliance with WTO provisions, the US and European poultry producers have been able to dump the Indian markets with cheap chicken legs at throwaway prices (around Rs.35/kg). The leg quarters treated as dark meat have low demand in their own country, while being considered as delicacy in India. This has hurt the domestic industry badly. Like, for poultry meat and meat preparations, the volume of trade (both, exports and imports) in eggs has also increased in the recent years. There has been a quantum jump in the egg imports from UK and USA in the previous two years. Surprisingly, in 2002/03 when US egg exports were facing a downswing due to disease outbreaks in the country, India imported large quantities of eggs from USA!

The heat of cheap imports was felt by the Indian dairy industry too, when the tariff on SMP was reduced to zero percent. The imports of milk & cream concentrated or sweetened (primarily SMP) which were on an average 2.8 thousand tones during 1993/94-1995/96 crossed 17000 tonnes in 1999/00, and the countries like Netherlands, Ireland, Argentina, Czech Republic, Poland and Thailand, which have not been our traditional suppliers of SMP also entered into the Indian markets. On account of successful re-negotiation of our bound rates and implementation of tariff quota for the product, its imports fell drastically in the subsequent years. The placing of dairy products under Open General Licence (OGL) has witnessed increase in imports of other dairy products like cheese and whey. Our principal suppliers of dairy products have been the European nations, USA and Oceania. The share of New Zealand and Australia in our dairy product imports is increasing. These two countries have gained the maximum share of world dairy markets after the implementation of AoA.

Australia and New Zealand are also our main suppliers of raw wool. The import of raw wool has increased consistently for the entire decade. The other livestock products like hides & skin and leather products are also imported in huge volumes. The imports of duty free hides and skins which had increased from the average volume of 11.8 thousand tones in 1993/94-195/96 to 19.9 thousand tones in 2000/01-2001/02 has declined to 15.3 thousand tonnes in last two years, primarily on account of decline in import of hides of bovine animals and sheep. Our principal suppliers of raw hides are European countries and Oceania. Sheep hide is also imported in substantial quantity from Arab countries.

Dairy Exports with special reference to Asia

Prospective Markets:

India has exported dairy products worth US$162.93 million to the world market during 1991 to 2004. About 82% of these (US$132.86 million) went to Asian countries. Out of 105 countries in the world, where during 1991-2004, at least for one year dairy exports took place, 40 were Asian countries.

The major export destinations in Asia are concentrated in Indian sub-continent, Gulf region and south-east Asia. Bangladesh is the most important destination with about 38 per cent share, followed by UAE, which accounts for nearly 29% of Indian dairy exports to Asian countries. The share of Nepal, Philippines, Sri Lanka, Oman, Bahrain, Singapore, Bhutan, Yemen, Kuwait and Hong Kong ranges from 6.5 to 1 percent. Thus, the top 12 countries account for about 95 per cent of the share in Asian markets, showing high degree of market concentration.

An interesting feature of dairy trade is emergence of some new Asian markets during post-globalisation period. Indian exports have picked up in four new countries, viz. South Korea, China, Iran and Israel after 1997, while another four countries, Taiwan, Lebanon, North Korea and Myanmar emerged as customers of our dairy products during 2001-04.

Prospective Products:

The composition of India's dairy export basket, shows that during the period 1991-2004, India has exported all the 6 product groups at least for one year. Milk and cream concentrated or containing added sugar or other sweetening matter is the most important item for exports. This subgroup contributes to more than two-thirds of the total exports of dairy products in the country. Another important tradable dairy product is butter and similar high-fat milk products like, butter oil, dairy spread. The perishability and bulkiness of product group milk and cream not concentrated restricts its trade, hence it has negligible share in the dairy product exports. Yoghurt and buttermilk and whey and whey-based products are exported in small amounts. In recent years, cheese has emerged as an important dairy item for exports to some countries.

A more disaggregated product profile in the Asian markets, further elaborate the nature of products exported from India. The prominent product lines regularly exported from India are: skimmed milk powder (SMP), whole milk powder (WMP), milk food for babies, other low fat milk powder, milk in powder or granular form with fat content exceeding 1.5%, butter and ghee. The average export value of these products has increased substantially in the post-WTO period, for instance, the average value of SMP exports increased from US$ 2727 thousands during 1994-96 to US$10605 thousands during 2001-04.

Some new products like, natural milk constituents and other cheese have entered export basket only after mid 1990s. The average export value of these products during the last triennium was quite high at US$ 300 and US$ 183 thousands, respectively. The other important new products are butter oil, condensed milk (sweetened) and processed cheese. A few products like unsweetened condensed milk, powdered cheese and some other fermented products have emerged in India's export basket in recent past years. These products have been exported only during the period 2001-04. In the times to come it would be of interest to see whether India continues to export these products regularly or not. Besides the above products, India has exported some products sporadically, namely yoghurt, butter milk, blue veined cheese.

Critical Issues in Enhancing Market Orientation of Livestock Sector

The production performance of the livestock sector has been impressive, yet to sustain the momentum and ensure that the benefits of buoyant national and international demand are translated into monetary gains for the livestock producers, it is imperative to enhance the market orientation of the livestock sector. A range of issues need to be addressed for this purpose:

1) *Maintain International Competitiveness*:

India has the competitive advantage in production of different livestock products. Producer prices of buffalo meat in India are lower than the international prices. A comparison of the producer prices has revealed that India has been a competitive country for most of the livestock products except poultry meat. India has the price advantage in bovine meat, mutton, pork and eggs; in bovine meat production it is highly competitive.

The producer price of poultry meat has been found significantly higher in India than the major exporters in the world market. In case of milk, though the producer price of milk gives some leverage to India, the cost of milk processing erodes its advantage, as dairy products are exports mainly in the processed form.

To take advantage of the opportunity of carving out a place for itself in the world livestock products market and protecting the domestic market from the onslaught of cheap imports, increasing the price competitiveness of our products is one of the major challenges in front of India.

2) *Upgrade infrastructure and undertake institutional reforms for ensuring food quality*:

On the quality front, India should improve its image as a reliable and consistent supplier of safe and quality dairy products conforming to the international standards enforced by the Codex Alimentarius Commission of FAO and WHO, through creating required infrastructure including cold chain in milk procurement and processing. Enhancing rural infrastructure is therefore, a challenge which government should take head-on for improving the quality standards of our products.

Further, a comprehensive strategy for producing quality and safe dairy products should be formulated with legal backdrop. In fact, India has too many food laws and too many ministries to implement them. This hinders efforts to maintain parity between national and international standards in the post-WTO era. As a result, India's exports fall short to continue escalation. Harmonization of BIS (Bureau of Indian Standards) quality standards with that of international quality standards will go a long way in materializing the export potential of Indian products into foreign currency.

3) *Need for structural changes in value chain:*

The unprecedented increase in demand for milk and milk products will present opportunities for poor people, who rear, process or market livestock and livestock products, to enhance their livelihoods. However, if the soaring demand coupled with increasingly stringent requirements of product quality intensifies industrialization of livestock sector, the small producers will find it increasingly difficult to compete with the industrial sub-sector and thus risk losing a significant means of livelihood. Therefore, there is need to enhance the participation of small holder livestock producers in market led growth so that benefits of market integration in globalised setup can percolate to them. In this context there is a need to explore alternative institutional arrangements for efficient integration of smallholder producer in the value chain.

4) *Commercialization of indigenous products:*

India has a rich tradition of making indigenous dairy products, particularly a large variety of *Channa* and *Khoa* based sweets. Although, several of these products are commercialized by the traditional sweet manufacturers (Halwaies) and creameries, yet their market is predominantly localised due to short shelf life of products, improper packaging, non-conformity with the consumer safety standards, etc. The availability of a few "branded" indigenous products (like, buttermilk, sweets) from Amul, Haldiram and others, is extremely limited to selected urban centres. The commercial potential of vast knowledgebase of recipes of sweets and other milk based products has not been adequately exploited. This calls for exploring innovative models for commercialising existing and new milk based products, beyond the boundaries of their place of origin.

5) ***Strengthening of R&D:***

The R&D efforts need to be strengthened even to maintain present rate of growth in production. India is a unique country where we have to go for the modern and latest technologies alongwith the traditional system for the long time to come. Therefore, the research and experimentation efforts to develop the technologies for all levels of livestock sector–production, procurement, processing, manufacturing, should be designed in the way so that latest technologies are used and the efficiency of the traditional system is also improved.

The research and experimentation efforts must essentially be focused on improvement of quality of milk and milk products, development of emerging technologies as high hydrostatic personal (HPP), pulsed electric feed (PET), value addition in buffalo milk with development of new products with special attributes, biotechnological application and mechanization for manufacturing of traditional Indian products at commercial side. Research effort are also required to generate accurate and up-to-date scientific data on new processing technologies, food packages, contamination and chemical risks, and the existing and changing food laws.

6) ***Negotiate for freer trade and fair SPS requirements:***

The reductions in distortions in the livestock products trade by developed countries, particularly in case of dairy products, are far from sufficiency to provide a level playing field to the developing countries like India in the international markets.

The tariff rates in developed countries are much higher as compared to India for almost all the livestock products. The continuance of high tariffs, domestic support and export subsidies by developed nations on the livestock products restricts the market access to their markets and makes very few Indian products internationally competitive. This calls for India to take up the critical issue of negotiating for more liberal trade environment. Currently, the WTO trade talks are at a stand still but, India alongwith other developing countries must continue to work on the agenda of seeking 'freer trade' for their products in future rounds of the trade talks.

Similarly, sometimes SPS measures are used to shield domestic producers from economic competition. An SPS measure which is not actually required for health reasons can be a very effective protectionist device, and because of its technical complexity, a particularly deceptive and difficult barrier to challenge. In several instances, SPS measures do not appear to be compatible with Codex standards. For example, the requirement for aflatoxin content in groundnut is set at 15 parts per billion (ppb) by CAC. However, EC has a stricter standard of 4 ppb. Thus, even if Indian standards of 30 ppb are harmonized with CAC standards, EC standards prevent any import of groundnut from countries like India.

Drawing from over a decade of experiences in the implementation of SPS measures, the member countries, particularly, the developing nation should be more prepared to meet the international standards and continuously update their knowledge base. At the same time, they ought to re-negotiate for introducing greater transparency in the application of the SPS rules and regulations.

View of Panalist:

Dr. Basant Ram, Vice Chancellor, NDAU&T, Kumarganj emphasized that:

- Discussed on WTO and its impact on agriculture.
- Problems of surplus has deteriorated condition of farmers.
- Exports have virtually stagnated over last five years.
- Horticultural crops seasonal in nature should be promoted.
- Post harvest loss needs to be minimized.
- Incentive should be given to farmers by technical know how.
- Public private partnership models needs to be developed.

Dr. S.S. Kadam, Vice Chancellor, Marathwada Agricultural University, Parbhani (MS) expressed his views with respect to

EXPORT ORIENTED AGRICULTURAL PRODUCTION WITH CONTEXT TO WTO, GATT OPPORTUNITIES, STRATEGIES AND ACTION PLAN

Challenges

- One of the areas in which visible progress has been made in India after its in dependence is agriculture. Agriculture production increased to meet domestic needs and earn foreign exchange. Agriculture on light soil and drought prone areas is not remunerative for the farmers. Therefore innovative farmers look for diversification switching to seed production dry land horticulture, apiculture, sericulture, Dairy, etc. The reasons for agriculture to be a un-remunerative enterprise are yield losses due to unprecedented natural calamities, high cost of production and low returns. WTO regime has provided an opportunity to have better access to world market but at the same time imposes a challenge on the front of quality and cost of production. Continuous technology up gradation is important to lower production cost and to increase productivity and quality of exportable commodities.
- With World Trade Agreement global perspectives like food quality, consumer preferences, environmental concerns and IPR assumed greater significance. Therefore equity, sustainability, nutrition, employment and trade are new areas of concern for agricultural research.
- Other constraints are poor resources and low yield levels and low productivity, declining farm income, farmers indebtedness, small and marginal land holding, depleting ground water resources, land degradation, rainfall, soil, technological and socioeconomic reasons are constraints of rainfed agriculture.
- Constraints experienced in export of agricultural produce may be restrictive/ ad-hoc policy towards agricultural exports, high cost of production, lack of sound and efficient infrastructure, absence of storage/ cold storage facilities, market intelligence, poor quality products, lack of certification agencies, inadequate extension trade, over dependence on few markets.

Opportunities

- Opportunities for efficient supply chain, direct marketing, training farmers, enhanced production efficiency, contract farming, investments in farm sector, promotion of frontier area researches in export, reorientation of research for export promotion exist. Selection of varieties, standardization of export protocol, strong branding, attractive packaging, advertising and measures to reduce transportation cost are other areas for promotion of exports in global market. We are exporting basmati rice, fish and fish products, spices, processed fruits and vegetables, flowers, tea and coffee. However, there is a scope for export in sericulture, milk and milk products, meat and meat products, mushroom, MAPs, castor oil, etc.

Strategies

- In India out of total net cultivated area of 97 million hectares (68%) about 97 million hectares are rainfed which produce 40% human population and 60% livestock. Therefore revitalization of rainfed agriculture system is necessary to ensure export competitiveness.
- Strategies to revamp rainfed agriculture in the context of WTO comprise off season tillage, sloughing, in-situ moisture conservation, early sowing, selection of crop as per land availability, proper plant population, timely weed control balanced fertilizer use, need based plant protection, water shed approach, crop diversification, farm mechanization etc.
- Input use efficiency (seed, plant, water, nutrient, fertilizer, pesticide, etc.), marketing and post-harvest management, product diversification through value added products, off season production, demand driven agricultural production, export oriented production through advance agro techniques, pest disease forecasting models, prolonged storage and shipping quality, evolution of crop varieties tailored to processing/ export, poly houses/ shade nets/ green houses, domestic market, price prediction models, etc. can be considered for agricultural competitiveness.
- Strategies for agricultural competitiveness include infrastructural recommendations like post harvest handling, cold chain, pack houses, access to rail, port, cargo, terminals, processing units, food/ bio-technology parks, fully developed agri-export zones, video conferencing facilities, techno – infrastructures, with erection of phytosanitary laboratories, modernization of quarantine facilities, making export licensing mechanisms easy. Human resource development in frontier export technologies, market access, forum for co-ordination among farmers, exporters and importers.

Action Plan

- Establishment of export information centre.
- Strengthening of agri-export zones.
- Identification of potential export markets.
- Demand driven agriculture production.
- Planning/drawing research plan in tune with global market.
- HRD for export competitiveness aggressive export policies.
- Relaxing quarantine measures and subsidies by developed countries.

Bangali Baboo, Director, Indian Institute of Natural Resins and Gums, Ranchi also expressed his views by presenting a paper on

INDIAN NATURAL RESINS AND GUMS – AN ECOLOGICAL APPROACH FOR ECONOMIC DEVELOPMENT

1. Resins and Gums

All the natural resins are of vegetable origin with the exception of lac and similar insect exudations which harden on exposure to air. They are insoluble in water but usually dissolve readily in alcohol, ether, carbon bi-sulphite and certain other solvents.

Natural gums come out as exudates from the trunk of a gum producing tree as a response to injury. Gums also extracted from seeds, seed coats, micro-organisms etc. They are generally insoluble in oils or organic solvents like alcohols, ether, hydrocarbons etc. However, they are soluble in water or at least become soft and swollen when mixed with water farming sticky substances.

Natural gum-resins, as the name implies, consist of natural mixtures of gums and resins in variable proportions and therefore partly soluble in water and have a penetrating and characteristics odour and taste. Certain gum-resins contain small amount of essential oil. They are called oleo gum-resins e.g. *asafoetida*.

2. Application Areas

Resins are largely used in surface coating formulations for several applications like wood furniture polishes/ varnishes, paints, lacquers, food and pharmaceuticals, adhesives, insulations, cosmetics, handcrafts, jewelry etc. Some of the resins like lac are very good source of several bio-active compounds of various uses. The gums and gum-resins are mostly used in food (thickening/ gelling agents, stabilizers, emulsifiers), pharmaceuticals, cosmetics, textiles, chemical industries. In several application areas there are no substitutes for these natural products while in some synthetic alternatives are available and uses.

3. Production and Demand

Indonesia, Indian and China are among the World's major producers of gums and resins. India produces annually about 281000 t of these valuable natural products. Of these, about 55500 t are resins, 224000 t of gums and about 1500 t of gum-resins. India is traditionally largest producer of lac, guar gum and karaya gum. In recent years, due to back to the nature trend there has been a revival of interest in natural resins and gums extracted from forests by rural and tribal people who depend on these resources to sustain their livelihood. Tow-fold increase in demand is expected due to realization for eco-friendly and safe natural materials for human contact and consumption.

4. Export and Import – India

Annual average export during 2001-02 to 2005-06 was Rs. 7848 million. This included Rs. 1371 million of resins and Rs. 6363 million of gums. The average imports during the same period was Rs. 1497 million. This included Rs. 866 million of resins and Rs. 289 million of gums. Major export items are lac, guar, karaya, asafoetida and major import items are lac, resins, gum-arabic, asafoetida and olibaennum.

5. Role in National Economy and Livelihood Support

The gross value of goods and services provided by the forestry sector is estimated at an average of Rs. 26330 crores i.e. about 2.37% of GDP. Of this recorded forest revenue about 60% comes from minor forest products including gums and resins. The sector supports about 50 million population inhabiting forests and sub-forest areas and 70% of employment in the sector is in minor forest produce (about 1.6 million mandays). It is an admitted fact that neither the forests nor the tribals and port inhabiting these should be removed for environmental protection. The only approach appears to be developing minor forest products like natural resins and gums based economic activities in these area to uplift the poor and maintain required forest cover or vegetation.

6. Ecological Approach for Economic Development

Forests are not only important source of subsistence, employment, revenue earnings, raw material to a number of industries but also play pivotal role in ecological balance, environmental stability, bio-diversity conservation, food security and sustainable development. Extensive tree wealth exists outside continuous forested areas. Vegetation plays the most critical role in maintaining and regulating the living as also the non-living components of any eco-system. Besides this, there is revival of interest in natural resins and gums due to increasing recognition of their immense social, environmental and industrial development possibilities. For sustained economic development in and outside forest areas as also deserts and degraded lands, human intervention for plantations of economic value is essential. The interventions so far, largely focused on exploitation of these resources and plantations, if any, of less economic value trees such as fast growing trees. Plantation of economic value is expected to ensure sustained development with stable environment.

7. Processing, Value Addition and Marketing – An opportunity for enhanced income and livelihood support

Gums and resins are low volume, high value produce. These can be processed to add value in quality for higher returns. In some products value addition through primary processing alone results in 3 times higher returns. Developing products of commercial use would further augment returns, employment and export earnings. To achieve this an organised marketing support would be crucial. In India lac and guar gum are processed but for most of other resins and gums processing and value addition in meager.

8. Goal

Harnessing science, engineering and marketing through research and extension initiatives to support ecological approach for economic development of forests, sub-forests, mountains and deserts. Natural resins, gums and gum-resins are non-toxic, bio-degradable and eco-friendly for various applications. India being a mega bio-diversity centre, stands to gain and establish its leadership in this sub-sector.

Repporteears:

- Dr. A.K. Singh,
- Dr. Chattopadhyay,
- Dr. Atul Kumar

TECHNICAL SESSION-VI

Impact of globally oriented civilization on Indian agriculture.

Chairman: Dr. J.H. Kulkarni, Vice Chancellor, UAS, Dharwad

Co-Chairman: Dr. R.K. Samanta, Vice Chancellor, BSKVV, Mohanpur

Key note Address:

Impact of Intensive Agriculture on Natural Resources and Opportunities for Sustainable Agriculture

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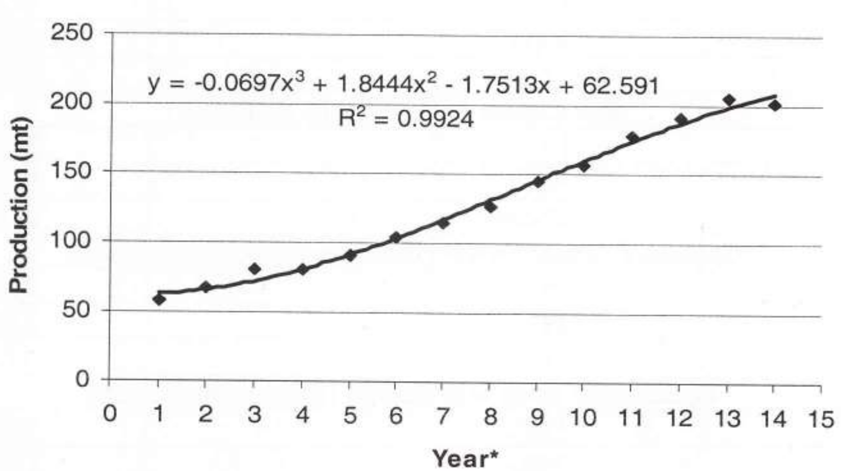
Agriculture is a significant contributor to Gross Domestic Product (GDP) in developing countries including India and provides employment to bulk of the people surpassing the contribution of the other sectors. The contribution of agriculture as a proportion of GDP was more than 50% in the 1950s, declined to 29 per cent during 1980s and the share further declined to 26 per cent in 1990s in the low-income countries. On the contrary, the share of agriculture in GDP was only three per cent during 1980s and two per cent in late 1990s in high-income countries (World Bank, 2000). In India, the contribution of agriculture in GDP was 55.4% in 1950-51, 52% in 1960-61 and has been reduced to 18.5% in 2006-07.

AGRICULTURAL SCENARIO CHANGE

India as a whole has made remarkable progress in food security, poverty reduction, and per capita income. The figure 1 shows the trend in foodgrain production over the years. A steady growth was recorded starting from 1966 till 1996, largely due to the phenomenal growth first in wheat and latter in rice production, as a result of green revolution. The growth rate, however, declined after 1996 and the production rather stagnated over the last five years. The stagnation in foodgrain production can clearly be deduced from figure 2 depicting the wheat productivity in Punjab, a state that signifies the green revolution of India. As shown in Tables 1 India has marched ahead from poverty to middle income within a period of three decades. However, the gains have not been shared equally; many rural households, disadvantaged groups and resource-poor areas have been left far behind. Women bear the maximum brunt of poverty and female-headed households are among the poorest. There has also been serious environmental degradation in many areas. Some of this has been in the green-revolution areas and is probably associated with the misuse of modern farming inputs and techniques. In India, agriculture contributed 51.3% to the GDP during the 1950s (Agriculture in Brief - 1967, GOI) and has gradually transited from being a primary producer to a producer of manufactured goods to the final phase of being a services sector driven economy. The growth rate in agriculture has not been able to keep pace with the substantial growth in services and lately industrial sectors (Figure 3). Agriculture's share in GDP fell from 31 per cent in 1993-94 to 18.5 per cent during 2006-07. Agricultural growth rate also declined from 3.2 per cent in the seventh plan to 2.3 per cent during the tenth plan. Growth rate of food grains also reduced during the above period. The coarse cereals witnessed a negative growth rate, while the major cereal rice declined.

Fig. 1 Foodgrain production in India



* 1 = Mean of 4 years 1950-51 to 1953-54

2 = Mean of 4 years 1954-55 to 1957-58 and likewise upto 13

14 = Mean of 5 years 2002-03 to 2006-07

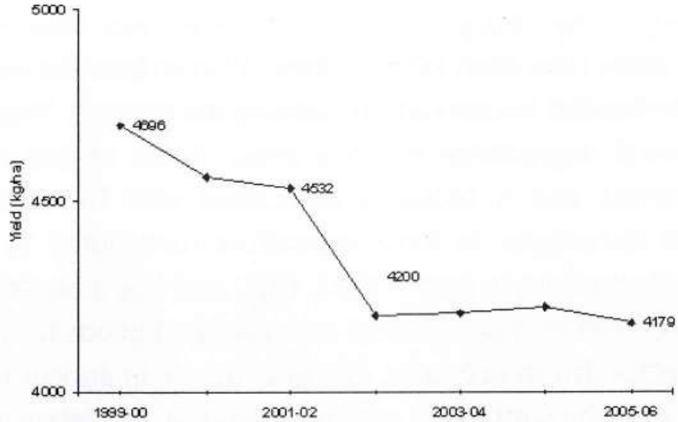
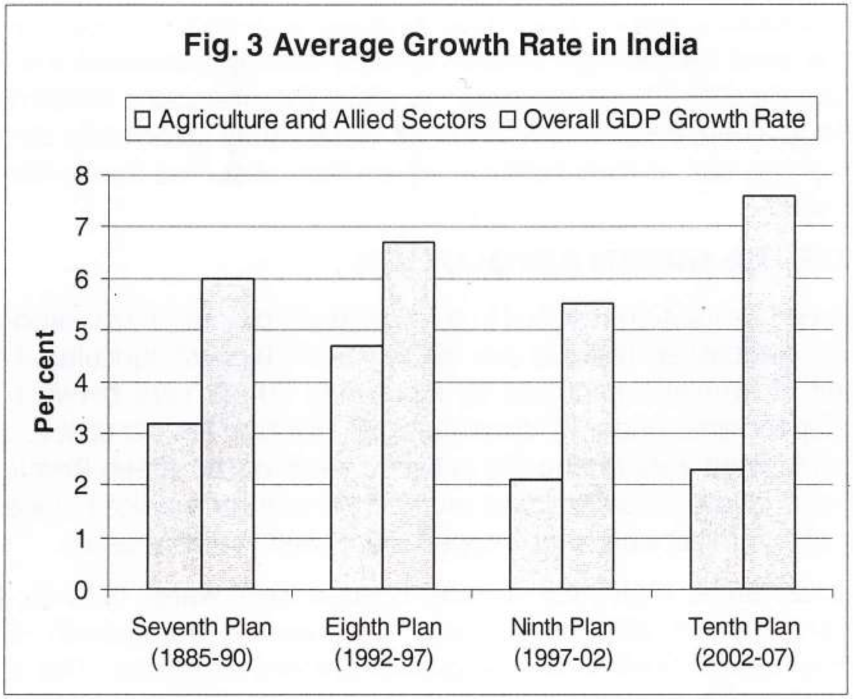


Figure 2. Decline in productivity of wheat in Punjab after 1999-2000

Table 1. Indicators of Change in India

Indicator	India
Population (millions)	
1970	554.9
2001	1028.7
% Change	85.4
Cereal Production (million metric tons)	
1970	92.8
2005	208.6
% Change	124.8
Per Capita Income (US $/Year)	
1970	241.0
2005	720.0
% Change	198.8
Calorie Consumption (Kilocalories/person/day)	
1970	2083
1995	2388
% Change	14.6
Foodgrain Area Harvested (million hectares)	
1970	123.7
2003	113.1
% Change	–8.6
Foodgrain Yield (t/ha)	
1970	0.805
2003	1.614
% Change	100.5



On the policy front three areas have to be tackled - land, water and financial resources to improve the agriculture sector in the country. Also, without an increase in the scale and rate of growth of infrastructure investment, growth rates are bound to remain moderate. The current concern is about the effect of climate change on agriculture. The challenges today, are to produce nutritious food for all at affordable prices and impart our farmers with the best technology enabling them to compete in the global market.

PILLARS OF GREEN REVOLUTION AND THEIR CONTRIBUTION TO INCREASE IN PRODUCTION

The Green Revolution introduced a new technology of production in agriculture. The technology consisted of a package of inputs, such as, high-yielding varieties of seeds, chemical fertilizers, herbicides, pesticides, machines like tractors, threshers, pumpsets/motors, combine harvesters/ reapers and others. The proper usage of these inputs required an assured irrigation system, a peasantry with the will and capacity to adopt the new technology and a government willing to lend its support and investment. High-yielding dwarf varieties of wheat from the International Centre for Maize and Wheat Improvement (CIMMYT) Mexico, were introduced leading to breakthrough in agriculture. The availability of assured irrigation for fertile lands provided a conducive environment that enabled a dynamic peasantry to accept innovations in seed technology. Several farmers already possessed the immediate capacity (supported by the government) to make the necessary investments in the new technology. These initial innovators were immediately followed by other farmers, irrespective of the size of their holdings, when they observed the sudden jumps in per hectare yield.

IMPACT OF THE GREEN REVOLUTION

The Green Revolution resulted in a record grain output of 131 million tonnes in 1978-79. This established India as one of the world's biggest agricultural producers. Yield per unit of farmland improved by more than 30 per cent between 1947 and 1979. The cropped area under HYV varieties grew from seven per cent to 22 per cent of the total cultivated area during the initial 10 years of the Green Revolution. More than 70 per cent of the wheat cropped area, 35 per cent of the rice cropped area and 20 per cent of the millet and corn cropped area, used the HYV seeds.

Crop areas under high-yield varieties needed more water, fertilizer, pesticides, fungicides and certain other chemicals. This spurred the growth of the local manufacturing sector. Such industrial growth created new jobs. The demand for irrigation created the need for new dams to harness monsoon water. The water stored was used to create hydro-electric power. This in turn boosted industrial growth, created jobs and improved the quality of life of the people in villages. India paid back all loans it had taken from the World Bank and its affiliates for the purpose of the Green Revolution improving India's creditworthiness in the eyes of the lending agencies.

India transformed itself from a starving nation to an exporter of food. This earned admiration for India in the community of nations, especially in the Third World. The impact of green revolution was dramatic in the state of Punjab. Between 1965-66 and 1970-71 the per hectare yield of wheat doubled, from 1104 kg per hectare in 1965-66 to 2238 kg in 1970-71. Following the success of the new technology in wheat in the mid -1970s, a breakthrough was achieved in dwarf high-yielding varieties of paddy. After wheat, paddy provided a major push to agricultural prosperity in the state. By the mid -1980s, except for the southern parts of Punjab, the state began to follow a' wheat-paddy rotation' pattern in cultivation, and, as a consequence Punjab became the food bowl of the country. It increased cropping intensity from 126 percent in 1960-62 to 185 percent in 1996-97, and the net sown area as a percentage of the geographical area rose from 75 to 85 during this period. The number of tractors rose from 10,646 in 1962-65 to 234,006 in 1990-93 and pumps sets from 45,900 to 721,220. Fertilizer (NPK) consumption increased from 30,060 tonnes in 1962-65 to 1212,570 tonnes in 1990-93.

ADVERSE EFFECTS OF THE GREEN REVOLUTION

The Green Revolution technology worked very well until the beginning of the 1980s. But subsequently agricultural began to show signs of fatigue. Productivity slowed and stagnation set in. Additionally, the Green Revolution technology has put great pressure on the ecological system, leading to a fall in the level of the ground water table, and soil fertility depletion. The Green Revolution, howsoever impressive, has thus NOT succeeded in making India totally and permanently self-sufficient in food. In 1979, 1987 and 2002, India faced severe drought conditions due to poor monsoon; this raised question whether the Green Revolution was really a long-term achievement. In 1998, India had to import onions. Recently, India has been importing wheat.

India has failed to extend the concept of high-yielding seeds to all crops or all regions. In terms of crops, it remain largely confined to foodgrains only, not to all kinds of agricultural produce. In regional terms, only Punjab and Haryana states showed the best results of the Green Revolution. The eastern plains of West Bengal, western UP, coastal AP and Tamil Nadu also showed reasonably good results. But results were less impressive in other parts of India. Nothing like the Bengal Famine can happen in India again. But it is disturbing to note that even today, there are places like Kalahandi (in Orissa) where famine-like conditions have been existing for many years and some starvation deaths have also been reported.

The Green Revolution has also been widely criticized for causing environmental degradation. Excessive and inappropriate use of fertilizers and pesticides has polluted waterways, poisoned agricultural workers, and killed beneficial insects and other wildlife. Irrigation practices have led to salt build-up and eventual abandonment of some of the best farming lands. Groundwater levels are retreating in areas where more water is being pumped for irrigation than can be replenished by the rains. And heavy dependence on a few major cereal varieties has led to loss of biodiversity on farms.

(i) Imbalanced fertilizer nutrient use

The fertilizer consumption in India is grossly imbalanced since beginning. It is tilted more towards N followed by P. Further decontrol of phosphatic and potassic fertilizers resulted in more than doubling the prices of phosphatic and potassic fertilizers. Thus, the already imbalanced consumption ratio of 6.2:4:1 (N: P: K) in 1990-91 has widened to 7:2.7:1 in 2000-01 as against favourable ratio of 4:2:1. As food grain production increased with time the number of elements becoming deficient in soils and crops also increased. The number of elements deficient in Indian soils increased from one in 1950 to 9 in the year 2005-06 which might further increase by the year 2025 if the imbalanced fertilization continues.

(ii) Depletion of soil fertility

Declining soil fertility is often cited as one of the most important reasons for stagnating or declining yields. In the early sixties, when fertilizer responsive varieties were introduced optimum yields could be obtained with the application of nitrogenous fertilizers alone. However, the bumper harvests soon depleted other nutrients and their deficiencies started limiting crop yields. Within a few years phosphorus and zinc deficiencies appeared in a big way in Indo-Gangetic plains. The support price policy of the government of Punjab for rice and wheat encouraged the farmers to grow rice in coarse textured non-traditional paddy growing soils. This resulted in the appearance of iron deficiency. More recently, the deficiency of manganese has been observed on wheat and rabi following rice on sandy soils. The sulphur is fast becoming a limiting nutrient in many soils of the country, particularly under pulse and cropping systems. Increased use of low S concentrated fertilizers and replacement of ammonium sulphate and single superphosphate by urea and diammonium phosphate, respectively has caused S deficiency. Sulphur deficiency has been frequently observed in wheat in coarse textured soils of Punjab, which can be corrected with the use of single superphosphate or gypsum as a source of P and S (Nayyar et al 2000). After N, Zn is perhaps the most important nutrient limiting yields in rice-wheat cropping system. Zinc deficiency has been recognised as a widespread nutritional disorder in rice on sodic and calcareous soils having high pH, low organic matter, high available P or Si, high Mg:Ca ratio and low available Zn (Nayyar et al 2000). Rice is relatively more sensitive to Zn deficiency than wheat. To delineate the extent of micronutrient deficient areas, more than 2.5 lakh soil samples were analyzed which indicated 49, 32, 12, 5, and 4 % deficiency of zinc, boron, iron, manganese and copper (Table 2) (Singh 2001b).

(iii) Declining and rising water table

The technological developments in ground water extraction and preference of crops requiring more water have led to phenomenal increase in the ground water utilization. Presently ground water is used to irrigate almost 75% of total irrigated land in the country. However, over-exploitation of the resource is forcing fall in the ground water table in many regions of Haryana, Punjab, Tamilnadu and Rajasthan and Union territories of Chandigarh, Delhi and Lakshdweep. The water table has fallen in about 80% area of Punjab constituting largely central districts of Amritsar, Kapurthala, Jalandhar, Ludhiana, Nawansheher, Sangrur and Patiala. The drop from 5-10 m in 1973 to below 15 m in 2002 in a sizeable area (25%) of central Punjab is really of big concern.

Name of States	Per cent deficient samples				
	Zn	Cu	Fe	Mn	B*
Andhra Pradesh	46.8	<1	2.8	1.0	52.9
Assam	34.0	<1	2.0	20.0	
Bihar	54.0	3.0	6.0	2.0	37.0
Gujarat	23.9	4.0	8.0	4.0	2.0
Haryana	60.5	2.0	20.0	4.0	0.0
Him. Pradesh	42.0	0.0	27.0	5.0	
Jammu & Kashmir	12.0				
Karnataka	72.8	5.0	35.0	17.0	32.0
Kerala	34.0	3.0	<1	0.0	
Madhya Pradesh	44.2	<1	7.3	0.0	21.8
Maharashtra	83.0	0.0	24.0	0.0	
Meghalaya	57.0	2.0	0.0	23.0	
Orissa	52.5	<1	0.0	0.0	23.3
Pondichery	8.0	4.0	2.0	3.0	
Punjab	46.1	1.1	14.0	2.3	23.4
Rajasthan	21.0				
Tamil Nadu	58.6	6.0	17.0	6.0	21.0
Uttar Pradesh	45.7	1.0	6.0	3.0	24.0
West Bengal	36.0	0.0	0.0	3.0	68.0
All India	48.8	3.0	11.9	4.4	31.8

Source: Singh M. V. (2001b), * Based on 50,000 samples

The region occupies a prominent position in the production of 67 and 56% to total rice and wheat, respectively, of the state. Due to fall in the ground water, the cost of pumping water has increased manifold. The existing 4 lakhs centrifugal pumps would require replacement with the submersible ones at a whopping cost of Rs. 3000 crores. Besides this, the energy requirement will also be doubled. Greater increase in summer rice in West Bengal is also causing heavy withdrawals of ground water forcing its decline, especially in medium land-toposequence. Besides more energy requirements, the change-over is aggravating the problem of arsenic toxicity especially in West Bengal. The intrusion of saline sea water into the inland aquifers due to more exploitation of ground water is also threatening the agricultural productivity of coastal areas. In almost all the irrigation commands, the water table has a rising trend by 0.1-1.2 m/year. The benefits of the major and medium irrigation works were, therefore, spectacular for the first 10-20 years, but these diminished with the occurrence of water logging and secondary salinity. It has been estimated that 4.5 m ha area in irrigation commands has been affected by water logging, thus, lowering the productivity of the lands.

(iv) Pollution of Ground Water

The consumption of fertilizers has increased under intensive agriculture in certain areas. The N fertilizer use efficiency being only 30-35 per cent, measurable amounts of nitrate nutrient reach the underground water resources. Eutrophication of water bodies due to high nitrate and phosphate concentrations, increasing levels of nitrates in drinking water sources, accumulation of heavy metals such as lead and cadmium in soils and water resources are the principal causes of environmental concerns due to fertilizer use in agriculture (Bajwa et al., 1993). Many wells in the vicinity of villages have been found to be unsafe being contaminated with nitrates. Some nitrosoamines, formed by the reaction of nitrate with secondary amines, are suspected to be carcinogenic. A study of ground water nitrate levels conducted by IISS, Bhopal revealed that groundwater contamination with nitrate beyond WHO drinking water standard was recorded to the tune of 10-20% samples in the districts of West Godavari, Ferozepar, Coimbatore and Hoshangabad. The results also indicated that drinking water sources near habitation areas especially from open well and shallow hand pumps contained more nitrate that irrigation sources in crop field areas. Organic sources of nutrients including wash-off of agriculture residues, human and animal excreta especially near habitation areas rather than inorganic sources seem to have played the major role in nitrate contamination of groundwater.

(v) Soil Degradation

Agricultural intensification has shown negative effects at different scales, such as increased soil erosion, soil fertility decline and reduced biodiversity at the local level: depletion and pollution of groundwater and eutrophication of surface waters at the regional level: and changes in atmospheric composition and climate on a global scale. Soil degradation is a severe problem in India with high demographic pressure (Fig. 4). The figure shows that nearly 16 million hectares of land is suffering from acidity which results in the deficiencies of P, Ca, Mg, Mo and B and toxicities of Al and Fe. Enhancing sustainable food production will require integrated strategies for the use of land and water resources: a) agricultural intensification on the best arable land, b) rational utilization of marginal lands for agriculture, and c) prevention and restoration of soil degradation. The non-uniform use of the plant protection chemicals in different region, cropping systems and crops and indiscriminate use of these chemicals is a matter of increasing concern. Pesticides unlike fertilizers exhibit toxic effects on living systems and inhibit activity of living cells at low concentrations Several studies conducted independently by different workers in various parts of the country have detected residues of several chlorinated hydrocarbon pesticides in soils, waters and all types of agricultural produce.

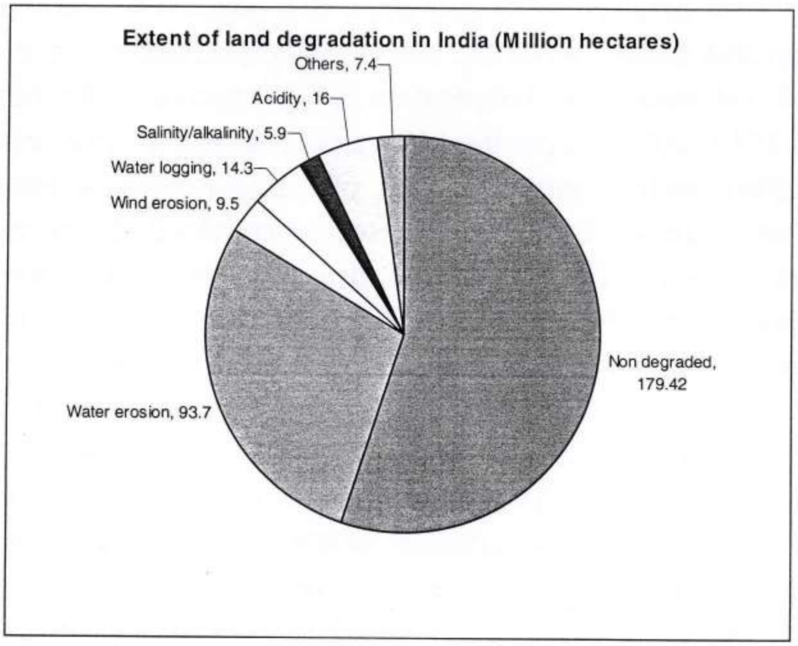


Fig. 4: Extent of soil degradation in India

There is a common practice of applying sewage and city composts to agricultural lands around cities. There is a possibility of contamination of edible parts of crops by the pollutant elements generally present in the waste. Peri-urban agriculture around cities produces a sizeable amount of agricultural produce particularly vegetables based on urban wastes particularly sewage and sludge. These wastes along with plant nutrients and organic matter also contain many toxic substances including heavy metals, pesticide residues, pathogens etc. Uncontrolled decomposition/mineralization of the wastes during raking for cultivation also provides lot of GHGs, NO_3 and other organic pollutants. Soil and water resources and food crops may also get contaminated by the pollutant elements from fall-out of various industries and automobiles near highways in urban areas. Geo-genic effects of F, B and Se in terms of diseases and toxicities are also becoming alarming in certain localized areas. To protect the public health, there is a need to investigate the status of these pollutants in the food and soil and water resources on which these crops are grown.

(vi) Environmental Impact

The global warming is becoming an important issue worldwide. The increase in GHGs was 70% between 1970 and 2004. The global warming is visible from the observation that eleven of the last twelve years rank among the 11 warmest years since 1850. The mean earth temperature bas changed by 0.74°C between 1906 and 2005 (DG, ICAR, 2007). As per the 1994 data of Ministry of Environment and Forest, the agriculture sector contributes 28% of the total GHG emissions from India. Coordinated efforts are being made by several countrie8 to reduce the emission of greenhouse gasses (GHG) to their pre 1990 level. Carbon dioxide (CO_2) chlorofluorocarbons (CFCs), methane (CH_4), and nitrous oxide (N_2O) in the atmosphere are the greenhouse gases (GHG) mainly responsible for global warming. Among the most GHG, CH_4 ranks only next to CO_2. Tropospheric CH_4 concentrations have more than doubled over the last 300 years. CO_2, N2O and CH4 emissions by soils are mainly of microbial origin. These. occur under different environmental conditions. Wetland rice could emit large quantities of N2O and CH4; strategies to reduce these gas emissions include proper management of organic inputs, temporary (mid-season) field drainage and direct seeding. The climatic conditions prevailing in India are favorable for denitrifies and carbon dioxide and methane producing microorganisms. However, direct. measurements of GHG and gaseous N under such cropping systems have seldom been undertaken. The approaches that can assist in reducing GHG emissions from agriculture are- improved water and fertilizer management in rice fields; improved management of livestock population and its diet; changing approaches to increase soil carbon such as organic manures, minimal tillage, and residue management; use of nitrification inhibitors, such as neem-coated urea, and fertilizer placement practices; enhancing energy use in agriculture by using better designs of machinery , and by conservation practices (DG, ICAR, 2007).

(vii) Loss of Soil Organic Matter

Loss of soil organic carbon is an important factor responsible for significant fatigue in the productivity under continuous cultivation, especially of rice-wheat cropping practiced on 11.5 Mha in the country particularly in the Indo-Gangetic plain. It is very exhaustive cropping system with nutrient removal s of about 500 kg ha^{-1} of N, P_2O_5 and K_2O in one cropping cycle. A negative nutrient balance has thus been commonly observed in rice-wheat system. Declining nutrients in the soil also lowers the sequestration of carbon in the soil that leads to further decline in soil fertility. The long-term fertilizer experiments conducted over several years in different agro-ecosystems of Indian reveal that the integrated nutrient management (INM) including NPK along with FYM improved SOC and enhanced crop productivity

CALL FOR EVERGREEN REVOLUTION

The pioneer of Indian Green Revolution, Dr. MS Swaminathan, presently chairman of *National Commission on Farmers* gave a new call for "Evergreen Revolution" for doubling the present production of foodgrain from 210 million tonnes to 420 million tonnes. For making "Evergreen Revolution" a success, he stressed on adopting best scientific techniques and promoting organic farming. He mentioned four prerequisites for getting the success.

(i) Promoting soil health

(ii) Promoting lab to land exhibitions

(iii) Making rainwater harvesting compulsory

(iv) Providing credit to farmers on suitable conditions

OPPORTUNITIES FOR CORRECTING THE ENVIRONMENTAL DEGRADATION

The continuation of widespread poverty apart, the biggest danger that India faces is the wanton destruction and degradation of all the country's natural resources and a growing, unsustainable, dependence on the use of hydrocarbon fuels. We are losing ten per cent of our GDP as a result of the damage to and degradation of our natural resources (Pachauri, 2004). The ever-growing pressure of population for food, fodder, fibre and feul needs, has been degrading our natural resources, giving rise to a multitude of resource degradation and environmental problems. A great deal of concern is already being voiced by researchers, planners, environmental activists and farmers alike on some of emerging problems of stagnating crop yields in Indo-Gangetic plain, rising cost of cultivation, rising and falling water tables in Punjab, Haryana and Rajasthan, development of secondary salinity in major irrigation commands, rice residue burning in Punjab, Haryana and Western U.P., pollution of soils, waters and foods in peri-urban areas and emission of greenhouse gases. Such changes in the resource base impacting ecosystem health need to be constantly monitored and understood extensively to devise adequate safeguards against them. Hence, the sustainable management of natural resources is essential for food security, nutritional security and environmental safety of the country.

(i) Fertilizer consumption and productivity

Over the last 35 years, 50-55 per cent improvement in crop productivity could be attributed to fertilizer inputs. Consumption of fertilizers in India increased steadily over the years, but their use efficiency remained low (30-50% for N, 20-25% for P and 2-5% for Zn, Fe & Cu). Achieving greater fertilizer Use Efficiency (FUE) is important as inefficient use of fertilizers represents substantial economic loss and an environmental degradation. At present level of fertilizer consumption and assuming use efficiency of 50% for N and 20% for P, a 1% increase in the efficiency of N and P use would save 2.19 lakh tonnes of N and 1.98 lakh tonnes of P, which together translate to a monetary gain of Rs. 6250 million annually. But FUE in terms of incremental crop grain yield response is on decline. A simple regression analysis was made between food grain production and fertilizer consumption for each 10 year period starting from 1950-51 and the relationship equations are given in Table 3. Increase in the intercept value of these equations over decades suggests gains of overall technological advances other than fertilizers. In the initial decade of 1950-51 to 1959-60, when chemical fertilizer had just arrived on the scene, the PFPf (Partial factor productivity of fertilizer) was 94.6 kg grain/kg fertilizer which declined to 10.52 kg grain/kg fertilizer during 1960-61 to 1960-70. This deceleration continued further and in the terminal decade of the last century it was reduced to only 5.36 kg grain/kg fertilizer. The crop productivity during this period is negative for all the crops except wheat. The long term effect of chemical fertilizers and manures applied individually and in combination on yield of crops and soil health were studied at 11 major agro-climatic regions of India under the All India Coordinated Research Project on Long-term Fertilizer Experiments (ICAR) since 1970-71. The response ratios to applied nutrients were computed for rice (Barrackpore), wheat (Barrockpore, Ludhiana, Pantnagar and Palampur), maize (Ludhiana and Bangalore) and finger millet (Bangalore) and are presented in Figure 5.

Table-3: Relationships between foodgrain production and fertilizer consumption in India.

Decade	Y=a+b	R^2	Correlation coefficient
1950-51 to 59-60	Y=52205**+94.59**X	0.64	0.80
1960-61 to 69-70	Y=74934**+10.52**X	0.50	0.71
1970-71 to 79-80	Y=88933**+6.64**X	0.40	0.63
1980-81 to 89-90	Y=88902**+6.99**X	0.86	0.92
1990-91 to 99-00	Y=112135**+5.36**X	0.72	0.89

Source: Rajendra Prasad (2006)
Where Y is food grain production in '000 tonnes, X is the fertilizer consumption in '000 tonnes,
* Significant at 1% level of significance;
** Significant at 5% level of significance

The application of N alone caused reduction in response ratio from initial 12.5 to 5 over 30 years primarily due to deficiency of P and K. The response ratio increased with the application of P along with N, but its reduction with time was again conspicuous in the absence of K application. The ratio got stabilized at a higher level only with the balanced application of NPK. With the addition of higher amounts of chemical fertilizers @ 150% recommended NPK response ratio rather declined. The response ratios appreciated with a rising trend only when chemical fertilizers were supplemented with multi-nutrient source of organic manure.

(ii) Maintaining Adequate Level of Soil Organic Matter through Integrated plant nutrition supply

The soil organic matter (SOM) is linked to the desirable soil physical, chemical and biological properties and closely associated with the soil productivity (Stevenson, 1986). As a chemical reservoir, there is a universal acknowledgement that SOM is the major indigenous source of the soil available N, that it contains as much as 65 per cent of the total soil P, and that it provides the significant of S and other essential nutrients (Bauer and Black, 1994). The soil organic matter also affects many soil surface condition. including the surface sealing, crusting, soil strength, water infiltration evaporation, conductivity and aeration. these conditions, in turn, affect the water conservation, soil erodibility, plant growth and yield. The biologically active SOM is believed to be the key to the soil productivity when the fertility is biologically mediated. The active SOM refers to a heterogenous mix of the living and dead organic materials that are readily circulated through the biological pools . the balance between the decay renewal processes in this

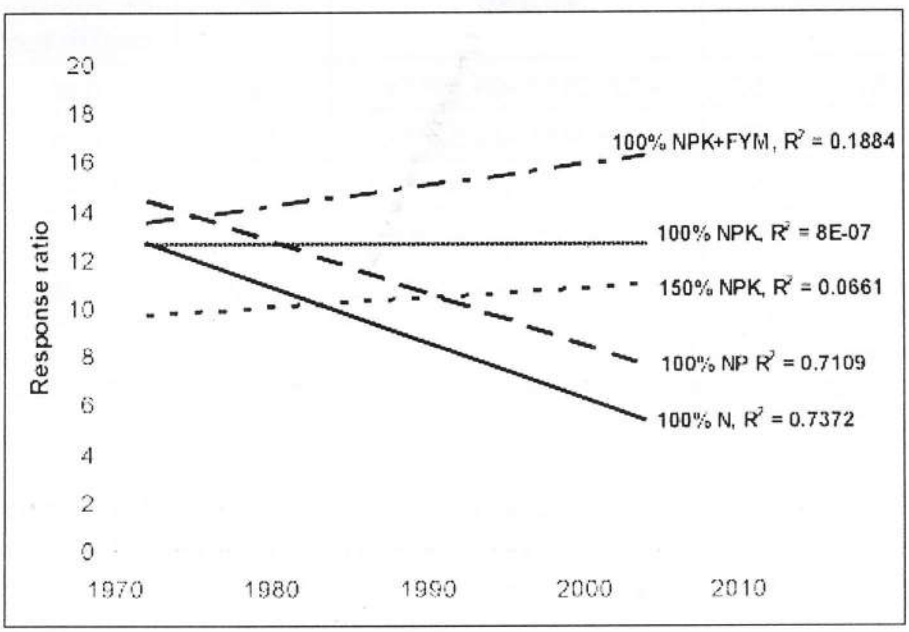
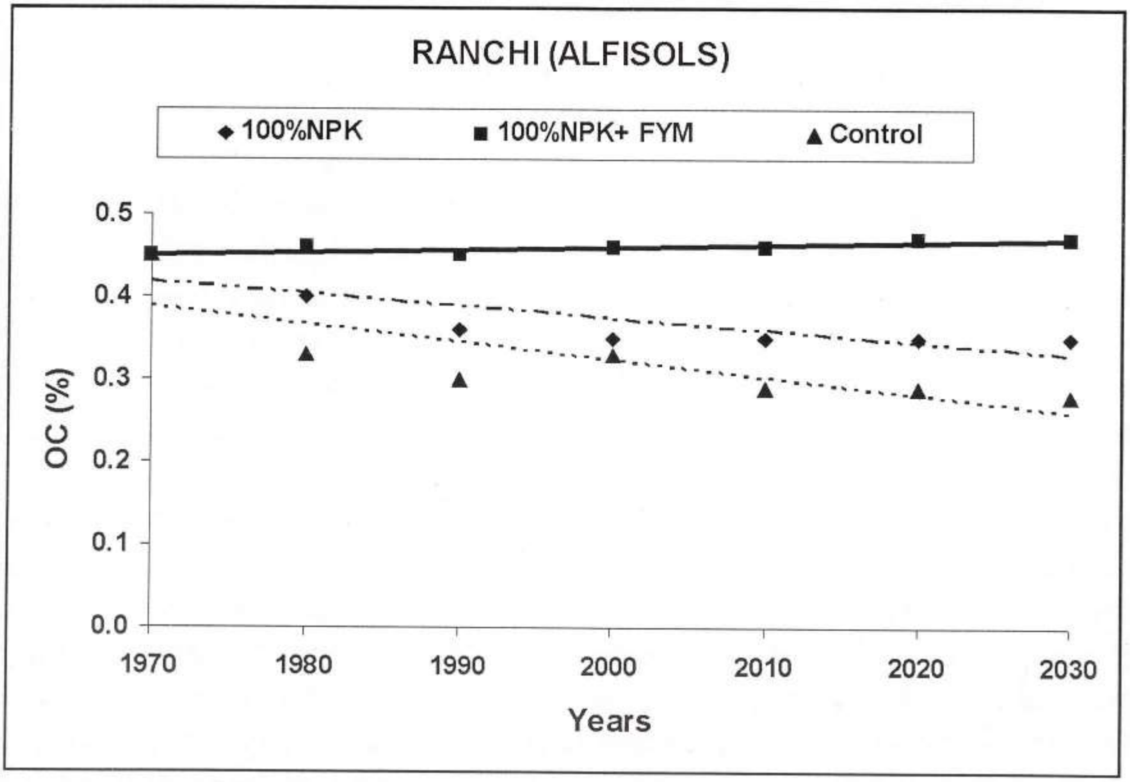


Fig.-5 : Nutrient response ratios (kg grain/kg nutrient) in cereals (LTFE data averaged over 1972-2003 and locations of rice, wheat, maize and finger millete)

The use of the adequate levels of organic manures and inorganic fertilizers is indispensable for the successful integrated plant nutrient management systems and for maintenance of soil organic carbon (Fig 6). Among the organic materials which have considerable potential are: farmyard manures: quick-growing leguminous crops grown as a part of the cropping system and incorporated into the soil at an appropriate stage as green manures: leguminous trees grown in hedgerows and their loppings are used as mulch materials or incorporated into the soil of the cropped alleys between them: forage or food legumes, properly inoculated with *Rhizobia,* grown in the cropping sequence: and the use of Azolla or blue-green algae with wetland crops.

(iii) Micronutrient management

Integrated use of organic manures either alone or in combination with zinc enhances the micronutrient status of soil and helps in correction of micronutrient deficiencies (Singh, 1994). Studies revealed that when farmyard manure is added regularly , the deficiency of micronutrient is taken care off automatically, other wise 10-12 kg Zn/ha (Table 4) needs to be applied to sustain the higher yield of various crops. When manure application is limited to 4-8 t/ha, application of zinc dose may be reduced to 3-6 kg Zn /ha thereby saving a chemical input by 50-75% without reduction in the yield (Singh 1994).



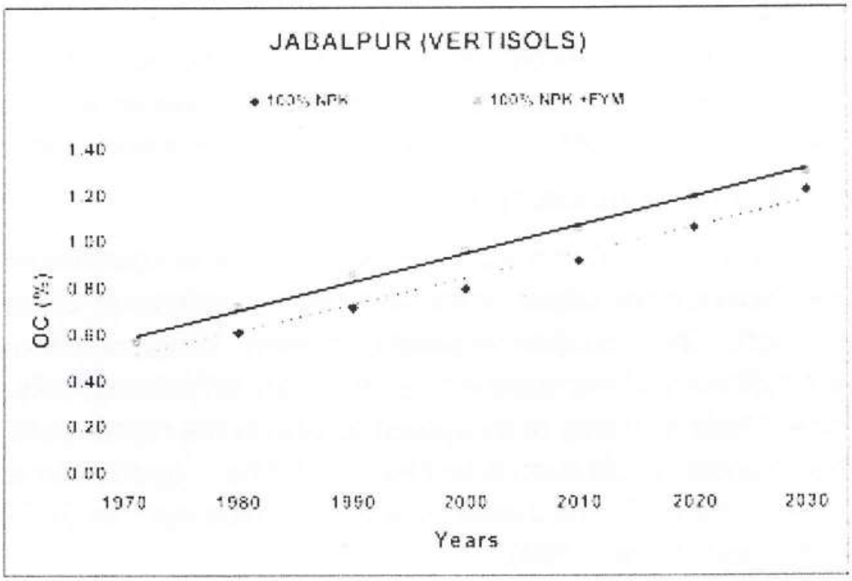


Fig. 6. Long term trend of soil organic carbon status in Alfisol (Ranchi) and Vertisol (Jabalpur) under soybean-wheat system.

Cereals showed greater response to zinc fertilization than pulses and oilseed crops. Out of 2211, 2525, 231 field experiments conducted on rice, wheat and maize 73, 57, 52% experiments showed grain yield response more than 200 kg/ha (Singh et al., 1979; Singh 1991). Data in table 5 clearly showed that in the initial phase of Green revolution the percentage of experiments showing less than 200 kg/ha was more but subsequently in nineties, the maximum number of experiments showed higher response between 200-500 kg/ha. This is because of continuous depletion of zinc content in soils due to intensive cropping. Not only cereals, but also oilseeds and pulses grown on marginal lands responded to zinc fertilization. Application of Zn significantly increased the yield and the magnitude of response varied from 28 to 135 kg seed per kg of zinc applied (Table 6) (Singh 2002). Pulses, cotton and sugarcane also significantly responded to zinc application. With the awareness of zinc deficiency and its impact on crop yields, the farmers have now been using zinc in several parts of country. As a result of this, zinc deficiency is declining while deficiencies of multi micronutrients like iron, manganese are emerging fast which are lowering yields. The manganese and boron deficiencies have been found in Indo-Gangatic alluvial plains. Copper deficiency is not a major problem in Indian crops and soils (Patel and

Singh 1995). However about 33% soil samples analysed form various parts of country indicated deficiency of boron (Table 7). Its deficiency is wide spread particularly in red and lateritic, acidic coarse textured alluvial and highly calcareous soils of Bihar (Sakal et al., 1996; Singh, 2000). Manganese deficiency is rapidly spreading in coarse textured alkaline soil having low organic matter content. Soil application of 20-50 kg Mn/ha is the optimum, but is highly uneconomical as compared to 2-3 foliar sprays of 0.5-1.0% manganese sulphate solution at weekly interval (Nayyar et al., 1990). The response of wheat and other crops to foliar sprays ranges from 200-3000 kg/ha over NPK. Most often manganese application decided entire failure or success of crop production in about 1.5 lakh hectares area (Singh, 2000). Data in Table 8 showed that tolerant cultivars need less number of foliar sprays of manganese as compared to susceptible cultivars of wheat (Nayyar et al., 1999; Singh and Saha, 1995). With continuous use of high-analysis fertilizers free from sulphur, the deficiency of sulphur has been widely observed. Its deficiency is becoming a major constraint for sustaining optimum yields of oilseed, pulse crops, onion and garlic (Singh 2001b). The crops grown in many areas are showing significant response ranging from 9-19 kg grain per kg of sulphur applied in case of Oilseeds and 4-10 kg grain per kg of sulphur applied to pulse crops in various agroecological zones of India . Balanced fertilization includes wide range of nutrient application strategies from N +Zn in newly-reclaimed alkali (sodic) soils to N+P+K+S+Zn in coarse-textured alluvial soils of the wheat belt.

(iv) Managing alkaline and acidic soils

Lime seems to be having conspicuous effect in increasing the response ratios (Figure 7) of acid soils. The figure shows about three times improvement in the response ratio of maize, finger millet and wheat in the presence of lime. In another experiment, yield of soybean and wheat showed decline in unlimed plots even with NPK application, over the last three decades of long term fertilizer experiment (Table 9). Even in 150% NPK, there was a reduction in the yield. In NPK + FYM treatment plots, however, there was no yield decline due to non-application of lime over the years. This shows that organic manures can substitute lime where the lime application is not possible. Another problem is that liming effect on soil is not permanent and one has to go for repeated application.

Table 4. **Mean response of rice-wheat sequence to different levels and frequency of zinc application in loamy sand soil of Punjab.**

Rate of application kg Zn/ha	Mean response (q/ha)*				
	Frequency of zinc application				
	All six rice crops	Alternate rice crop	I & IV rice crops	Initial rice crop	Mean
2.8	6.62	5.27	4.32	3.10	**4.83**
5.6	10.15	9.00	8.73	6.45	**8.58**
11.2	12.25	11.15	11.48	8.40	**10.85**
Mean	**9.7**	**8.5**	**8.2**	**6.0**	

* Mean of six cropping cycles,

** Mean yield in NPK 73.66 q ha^{-1} per rice-wheat cycle

Source: Nayyar et al. (1999)

Table 5. **Percentage of cases in different categories of response to zinc over years in farmers fields.**

Years	No. of trials	Percent distribution of experiments in different response range, kg /ha			
		< 200	200-500	500-1000	>1000
1975-76	250	44	41	15	0
1978-80	413	46	30	17	7
1981-84	489	22	40	30	8
1984-85	277	16	43	35	6
1985-86	103	21	44	27	8
1986-90	222	13	65	14	8

Source: Singh (1991)

Table-6: Response of oilseeds and pulses to zinc fertilization over NPK in front line demonstrations

Crop	No. of field Exps.	Seed yield, kg/ha		Response over NPK	
		NPK	NPK+Zn	kg grain / kg Zn added	Percent
Soybean	24	1109	1248	27.8	12.5
Ground nut	30	1509	1713	40.8	13.5
Gobhisarson	9	1595	1842	49.4	15.7
Linseed	2	1064	1316	30.4	13.8
Mustard	6	1352	1832	96.0	37.6
Raya	8	1499	2177	135.8	48.2
Sunflower	2	1610	2230	124.0	41.6
Cotton	27	1151	1370	44.0	14.5
All oil seed	108	1322	1578	50.1	18.2

Source: Singh (2002)

Table-7: Crop response to boron fertilization in field trials conducted on different soils.

Crop	No. of trials	kg grain /kg boron added	Per cent response over NPK
Rice	107	384	16.6
Wheat	35	468	15.1
Maize	5	684	32.5
Chickpea	7	420	44.1
Lentil	4	298	18.6
Groundnut	11	144	9.9
Sesame	5	108	23.9
Mustard	15	320	32.8
Sunflower	3	660	35.2
Cotton	2	312	11.6
Average	194	**380**	**24**

Source: Singh (2006)

Table- 8: Relative tolerance of wheat cultivars to foliar sprays of manganese sulphate

Cultivars	No. of sprays	Grain yield, t /ha				
		0	1	2	3	Mean
PBW 34	Susceptible	1.28	1.96	2.39	3.15	2.19
HDS 2285	Susceptible	1.87	2.95	3.61	4.30	3.43
Mean	**Susceptible**	**1.58**	**2.46 (57)**	**3.00 (90)**	**3.73 (136)**	**2.81**
WL 2265	Tolerant	4.12	4.29	4.75	4.79	4.49
HD 2329	Tolerant	4.15	4.78	4.98	5.11	4.73
Mean	**Tolerant**	**4.14**	**4.54 (10)**	**4.87 (18)**	**4.95 (20)**	**4.56**

Source: Nayyar et al. (1999); Singh and Saha (1995), Figures in parenthesis represent increase over control

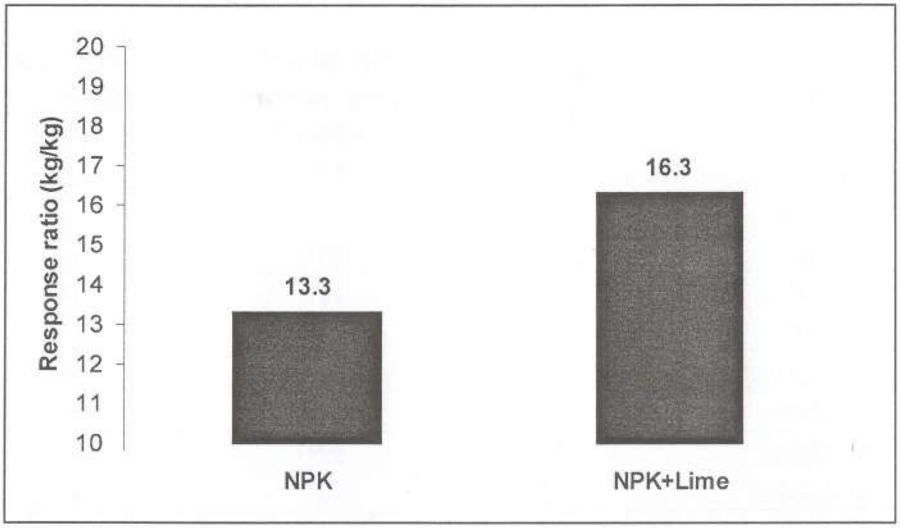


Fig.-7: Average response ratio to applied NPK in cereals in presence or absence of lime (LTFE data)

Table 9. Average grain yield of crops (q/ha) as affected by long term (1973 2001) use of fertilizers, lime and FYM in an acid soil.

Treatment	Soybean		Wheat	
	Grain yield	% change over NPK + lime treatment	Grain yield	% change over NPK + lime treatment
100% NPK	16.0	-12.3	26.5	-12.8
150% NPK	15.1	-14.2	28.0	-7.8
100% NPK+FYM	18.7	+7.2	31.9	+4.9
NPK%+Lime	18.1	-	30.4	-
C.D(P=0.05)	**2.3**	-	**3.8**	-

Source: Wanjari et. al. (2004)

The effect of long-term application of N, NP, NPK, Lime and FYM in a maize-wheat rotation on an acid red loam soil (Paleustalf), Ranchi, showed that maize crop responded considerably to N, NP and NPK application over unmanured control during the first 18 years (Lal & Mathur 1989a &b) and the magnitude of response increased in the order of application of nutrients. In contrast to NPK treatments, NPK plus lime (NPKL) or FYM gave higher yields of maize and wheat throughout the experimental period (1956-1984) by maintaining favourable soil pH. More than 871 trials on farmers' fields at various locations by Sharma and Sarkar (2005) demonstrated an incremental benefit of one tonne/ha by placing lime with seeding.

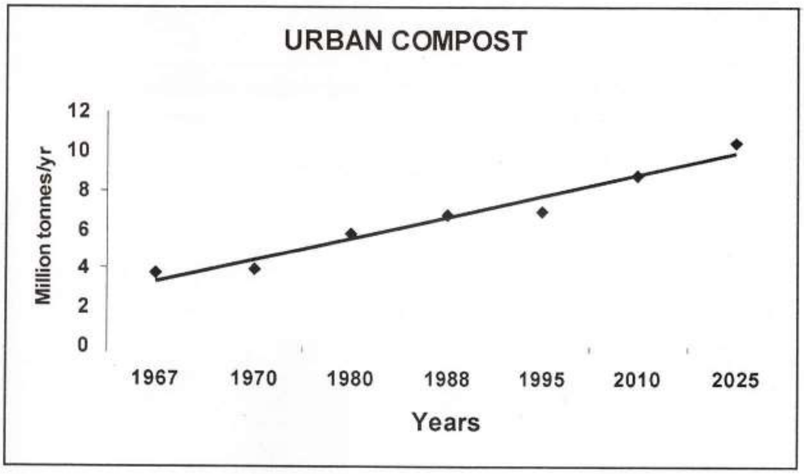
(v) Enhancing incentives for sustainable resource use

Public policy can play an important role in encouraging the sustainable use of natural resources. First, by correcting incentive-distorting policies that encourage unsustainable use of the resource base. Second, by identifying market based instruments for promoting the supply of environmental services through appropriate changes in agricultural production systems and land use. Input subsidies that keep input prices low directly affect crop management practices at the farm level. These policies have contributed to significant degradation of the agricultural resource base by creating soil fertility imbalances; disruptions in pest-predator ecology; salinity and waterlogging problems, and higher incidence of soil erosion. The human health costs associated with pesticide use is also well documented (Rola and Pingali, 1993). Increasing input use efficiency would help arrest many of the degradation problems mentioned above. With the progression towards global integration, the competitiveness of domestic cereal based agriculture can only be maintained through dramatic reductions in the cost per unit of production. Technologies for more efficient use of fertilizers, pesticides, and water are available and could become worthwhile adopting as price distortions are removed.

Governments can also play an important role in promoting eco-system conservation through changes in agricultural production systems that complement food and fiber production. Conservation tillage, agroforestry systems, and silvo-pastoral systems, are some of the many examples of agricultural production systems that can generate environmental benefits in the form of carbon sequestration, biodiversity conservation and watershed protection. The benefit of combining payments for the provision of public environmental goods such as soil carbon sequestration or watershed protection for the adoption of agricultural practices can eventually lead to increased agricultural productivity. Government has a role to play in stimulating desirable land use change as well. In the process of economic development, as agricultural populations shrink and non-agricultural sectors grow, the potential for setting aside land for non-agricultural uses is high. Conversion of marginal agricultural lands to forests contributes to carbon sequestration, watershed protection and biodiversity conservation. For developing country like India with similar conditions in the agricultural sector, national and international public sector support for land use changes that generate global environmental goods and services can be an important means of attaining sustainable resource use.

(vi) Management of rural and urban waste

The production of urban wastes would increase from 3.7 million tonnes in 1967 to 8.7 million tonnes in 2010 and 10.4 million tonnes in 2025 (Fig. 3). Soil scientists and other environmentalists have to play a pivotal role in converting these wastes into valuable manure through proper management. Use of organic manures is effective in stabilizing productivity under low to medium cropping intensity while integrated use of organic and chemical fertilizers provides stability and sustainability to crop production under modern intensive farming. Organic solid wastes generated in large quantities by domestic, commercial and industrial activities are often indiscriminately disposed on the soils. In recent survey (2005), it has been estimated that a large amount of urban compost is being generated every year from different cities of India which will reach to around 10.4 million tonnes per year during 2025 (Fig. 8) as a result of phenomenal increase in urban population (Fig. 9) and ever increasing industrialization. This could be increased to around 11 million tonnes per year at present and about 20.8 million tonnes per year by 2025, if entire compostable material (42%) under goes composting (Fig. 10). This, however, is possible by improving the composting technology of city wastes that is also cost effective. By following the proper composting techniques, the municipal solid wastes can provide an amount of 2.85 lakhs tonnes of N, P_2O_5 and K_2O that could increase to about 5.4 lakh tonnes per year by 2025. The currency value of compost is currently 158.3 crores and can go up to 659.6 crores by the year 2025 through the involvement of improved technology in compost making (Fig. 5).



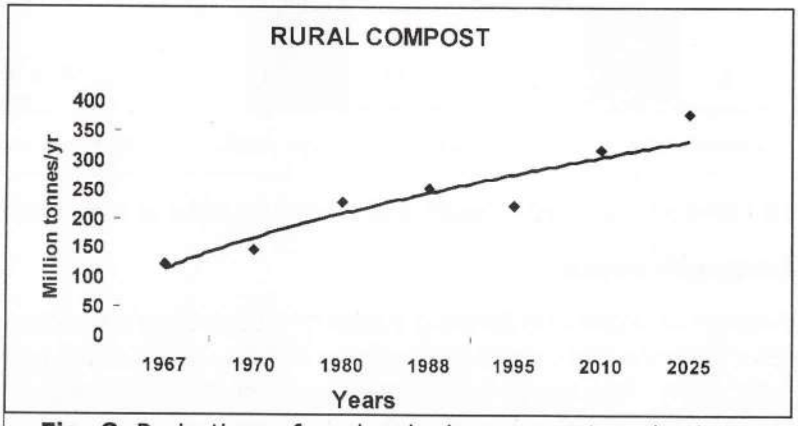


Fig.-8: Projections of rural and urban compost production

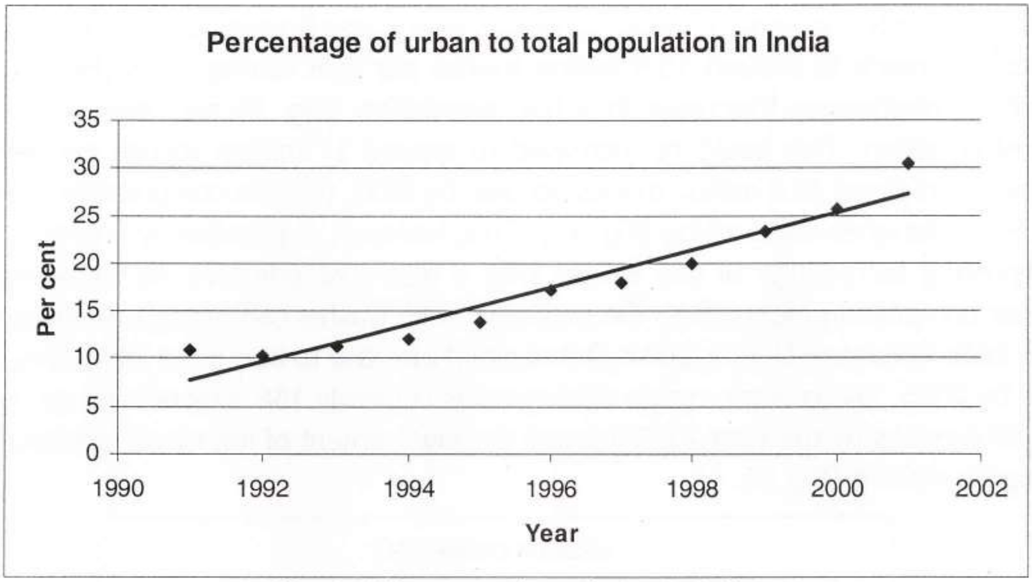


Fig. 9. Urban to total population in India

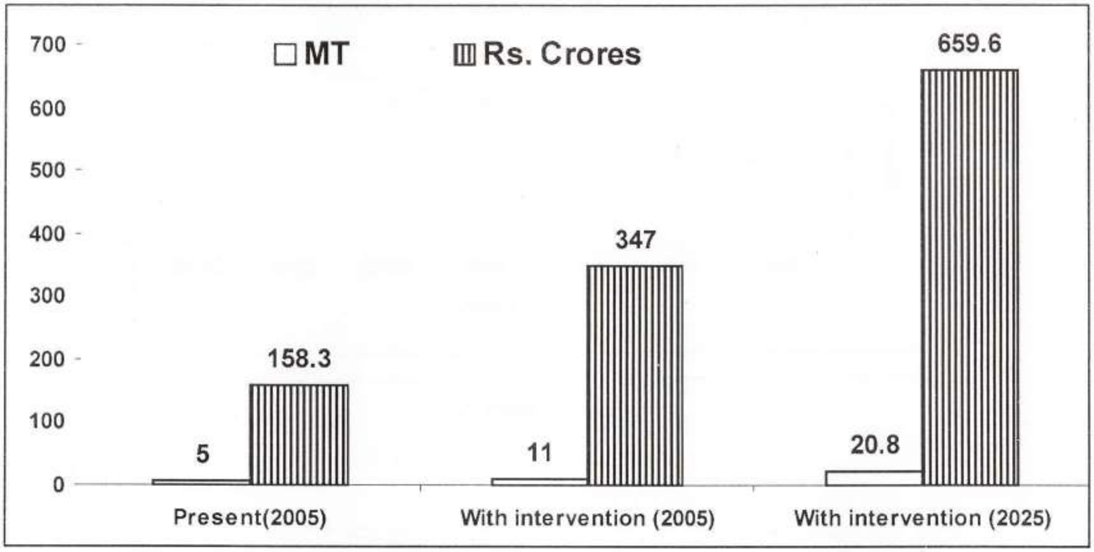


Fig. 10 Compost produced (amount and monetary value) in India and projectio

(vi) Crop Diversification

Diversification of crops and farming systems is becoming essential for maintaining soil health, water balance and overall productivity in many parts of the country, especially in Indo-Gangetic plain. This has to be achieved in synchronization with the soil, climate, availability of water and market potential Bawal in Haryana showed that inoculation of bacterial biofertilizers like *Azospirillum* and *Pseudomonas* on pearlmillet, wheat and mustard gave 10-22% increase in grain yield when applied alongwith 75% recommended doses of nitrogen and saved 25% N dose. Fifty field demonstrations in farmers' fields in six districts of Haryana showed that pearlmillet yields were improved and there was an increase of 15% in net income (Rs. 800/ha) earned by farmers through simple inoculation (Table 10). A number of field experiments with different rice varieties grown in Alfisols and Vertisols in Tamilnadu have consistently proved over the last five years that by applying AZOPHOS, a mixed Biofertilizer comprising of *Azospirillum* and Phosphate solubilising bacteria (PSB) through dipping of the rice seedlings in a slurry of the inoculum at transplanatation, about 25% recommended dose of N and P can be saved, i.e., yields at 75% NP with inoculum are at par with 100% recommended dose of NP (Table 11). In a long term experiment started seven years ago on inoculation of *Bradyrhizobium japonicum* in soybean and *Azotobacter* inoculation in wheat in Vertsisols of M.P., additional grain yields of about 200 kg in soybean and 300 kg in wheat have been recorded due to inoculation over and above the recommended dose of NPK. In terms of total additional nutrient uptake in crops and accretion in soil due to BNF it was found that this amounted to nearly 90 kg N/ha/yr. Combined inoculation of *Rhizobium* and a PGPR (plant growth promoting rhizobacteria) *Pseudomonas* saved 25% N and P in groundnut in Alfisols of Tamilnadu by improving nodulation (Table 13) and nitrogen fixation. In acid soils, micronutrients availability is reduced and since molybdenum and cobalt are co-factors of the nitrogenase enzyme, biological nitrogen fixation in root nodules is affected. Seed treatment of green gram with Mo and Co in acid soils of Orissa dramatically improved the yields, N and P uptake (Table 14).

Table-10: Summary of demonstration trials on mixed biofertilizers (*Azotobacter, Azospirillum* and *Pseudomonas*) on pearlmillet (var HHB 94) in Haryana (AINP on BF, HAU, Hisar)

Districts	No. of Trials	Mean grain yield (kg/ha)		Mean fodder yield (kg/ha)		Net return (Rs/ha)	
		IP	FP	IP	FP	IP	FP
Hisar, Bhiwani, Jhajjhar, Rewari Mahendergarh	50	1987	1891	5015	4732	5897	5116
% increase over FP	--	5.0 %		6.0 %		15.3%	

IP = Improved Practice: 75% RDF (30 kg N and 15 kg P. ha) + Mixed biofertilizers
FP = Farmers Practice: 75% RDF (30 kg N and 15 kg P. ha)
Net increase: Rs. 780/ha due to inoculation.

Table 11. Effect of Azophos* on rice (var. ASD 18) (AICRP-BNF, TNAU, Coimbatore)

Treatment	Grain yield (kg ha^{-1}) (var. ASD 18)	Grain yield (kg ha^{-1}) (var. white ponni)
100% N + P		
Uninoculated	**4343**	**5905**
Azophos	4520	--
75% N + P		
Uninoculated	3766	5760
Azophos	**4416**	**6000**
CD	492	240

**Azospirillum* + PSB mixed in same packet.
100% NPK was 120: 38: 36.

Table-12:. Yield and N benefits due to *Rhizobium* inoculation of soybean and *Azotobacter* inoculation of wheat (av. of 6 years 1999-2005) in Vertisols (AICRP-BNF, JNKVV, Jabalpur)

Treatment	Soybean yield (kg/ha)	Wheat yield (kg/ ha)	Soybean N uptake (kg/ha)	Wheat N uptake (kg/ha)	Soil N increment (kg/ha/yr) in Soybean-wheat	Total N benefit due to use of inoculants (kg/ha)
	A	B	C	D	E	C+D+E
Uninoculated	1651	4980	132	109	1425	
Inoculated	1855	5296	149	124	1486	
Gain	204	316	17	15	61	93

* N, P and K were applied at 20 : 80 : 20 to all plots in soybean

Table 13. Effect of combined inoculation of *Rhizobium* (TNAU 14) and plant growth promoting harmones (PGPR) (*Pseudomonas*-PS2) on groundnut (AICRP-BNF, Coimbatore).

Treatment	Nodule (no./ pl)	Nodule Dry weight (mg/pl)	Pod yield (kg/ ha)	% increase over control
100% NP				
Uninoculated	20	120	**1333**	--
Rhizobium + Pseudomonas	47	220	1492	11.9
75% NP				
Uninoculated	21	100	1001	--
Rhizobium + Pseudomonas	39	270	**1278**	27.6
L.S.D. (p=0.05)	3	35	69	-

* Inoculation saved 25% of the recommended doses of N and P in groundnut.

Table-14: Impact of combined application of *Rhizobium* and micronutrients on yield and nutrient uptake of green gram in an acid loam (AICRP-BNF, OUAT, Bhubaneswar)

Treatment	Grain (kg/ha)	Stover (kgha)	N uptake (kg/ha	P uptake kg/ha
Uninoculated	340	300	21.4	1.9
Rhizobium	430 (25.7)*	340	28.5	2.5
Rhizobium + Mo + Co	610 (78.4)	680	45.4	4.4
LSD (p=0.05)	50	60	2.4	0 48

*Figures in parenthesis denote per cent increase over uninoculated control; recommended doses of NPK were applied.

(ix) Water Management

Among several inputs water, energy and their nexus is very important for sustaining productivity of the country. Massive public investments created 25% of surface irrigation whereas private investments into ground water exploitation contributed 75% of total irrigation. The indiscriminate use of resources has, however, given rise to both declining and rising water tables in different parts of the country, putting a question mark on the sustainability of the agriculture. The estimated efficiencies of ground waters is 70% and offer opportunities to enhance over all efficiency by their integrated management. The declining trend in ground water level can be reversed by encouraging ground water recharge measures, enacting law for community ground water rights and dispensation of populist policies of free power and water to farmers. Lining of canal irrigation network, surface and sub-surface drainage, biodrainage and proper on-farm water management are recommended to check the rise in water table. On an average about 25% of India's ground water resources are of poor qualities and can be used conjunctively with canal supplies or after amending. Principles for groundwater management reform are similar to those for surface water, including the introduction of economic incentives and user involvement in the allocation process. The approach has to employ a variety of instruments to influence water demand, including pumping quotas (usually based on historical use), pumping charges, and transferable rights to groundwater. The governance structure in the water basin (shared aquifer) establishes water rights, monitoring processes, means for sanctioning violations, representative associations of water users, financing mechanisms for administration and management, and procedures for adapting to changing conditions. Key elements for the success of this governance structure are that it is agreed upon and managed by the water users; that it is responsive to local conditions; that it operates with available information and databases, rather than requiring theoretically better but unavailable information; and that it adapts to the evolving environment. Improvement in irrigation and rural literacy rate are the two most important critical factors for the recent growth as well as over all development of agricultural sector in India. Considering the important role of agricultural growth on poverty reduction in a region (Fan, et al., 1999; Mellor, 2001; Desai, 2002), these two factors of production (irrigation and literacy rate) have obviously a larger role to play in the overall rural development and poverty alleviation process in a nation.

Future strategy on poverty reduction in rural India still largely depends upon how efficiently the irrigation sector is managed and how effectively the level of irrigation access is provided to a large number of farmers in the regions that have still not benefited from the Green Revolution of the 1970s and 1980s. Thus, the irrigation access is in fact pro-poor strategy to alleviate the severity and gravity of the poverty in a region, as illustrated from the macro level aggregate analysis in this study. It is estimated that even after developing the full irrigation potential, nearly 50% of the total cultivated area will remain rainfed and important source of livelihood. The technological interventions in terms of improved seeds, fertilizer use, water conservation, harvesting and micro irrigation etc have a potential to increase the productivity of rainfed areas by about half a tonne per ha. The improved practices on 20 million ha of such lands could provide 10 million tonnes of additional food grains. For best results, the management of rainfed areas should be viewed within the perspective of participatory watershed management programmes. The meta analysis of 311 watersheds spread over India has revealed mean benefit-cost ratio of 2.14 (Table 15). The internal rate of return was 22 percent which is comparable with many rural development programmes. Irrigated area increased by 33.6%, cropping intensity by 63.5 due to 13% reduction in run off and soil conservation @ 0.82 tonnes/ha. The programme fits very well in the framework of National Common Minimum Programme and Rural Employment Guarantee Schemes of the Government.

The arid and semi-arid regions characterized by water scarcity have aquifers of geogenically low quality. About 32-84 % of ground water used in states representing arid and semi-arid, coastal and water logged regions is of poor quality. There are several agronomical and water quality amending options to use at least 10-15% of such waters to enhance productivity. The waste waters have traditionally been used as a source of irrigation to agricultural lands around cities. The waste water rich in organic matter and certain plant nutrients increases soil, fertility and crop productivity.

Table-15: Summary of benefits analysed by meta-analysis of 311 pilot watersheds implemented by various agencies in India.

Indicator	Particulars	Unit	No. of studies	Mean
Efficiency	B/C ratio	Ratio	128	2.1
	IRR	Per cent	40	22.0
Equity	Employment	Person days/ha/year	39	181.5
Sustainability	Irrigated area	Per cent	97	33.6
	Cropping intensity	Per cent	115	63.5
	Rate of run off	Per cent	36	-13.0
	Soil loss	Tons/ha/year	51	-0.8

Source: Joshi et al. (2005)

India generates about 17 million cubic metres of sewage water per day with a potential to supply 1-1.5 million tones of plant nutrients annually while irrigating about 1.5 m ha of land. Results from long-term field studies (Juwarkar, 1991) have shown that on an average of 15 crops, the maximum productivity was obtained with primary treated sewage followed by diluted (1:1) ratio, untreated sewage and least with well or canal water irrigated crops (Table 16). Even with application of full dose of recommended N, P and K through fertilizers with well/canal water, the yield levels were relatively lower. The nutrient utilization efficiency (9 kg of grain/kg nutrient) also increased considerably due to dilution of sewage and application of supplemental NPK through fertilizers. However, one has to look into public hygiene, sanitary, phyto-sanitary and food-safety considerations.

Table-16: Relative yield of crops irrigated with amended sewage and fresh quality water

Crop	Yield (Mg/ha)			
	Well/ canal water	Untreatesd sewage	Primary treated sewage	Diluted (1:1) sewage
	Nagpur			
Rice	3.8	3.3	4.3	4.1
Wheat	2.8	3.1	3.4	3.2
Soybean	1.6	2.1	2.3	1.9
Greengram	0.6	0.5	0.8	0.7
Chickpea	1.2	1.3	1.5	1.4
Cabbage	13.3	14.8	16.4	15.7
Cauliflower	16.4	18.2	19.7	16.9
Okra	3.1	3.4	4.8	4.0
Tomato	13.7	15.5	16.4	16.1
Brinjal	9.1	12.1	12.7	10.1
Potato	6.4	7.1	8.1	7.1
Sugarcane	42.7	44.4	48.5	43.3
Marigold	5.1	7.1	7.6	-
Daizy	8.4	9.7	11.4	-
Jasmin	3.7	3.4	4.4	4.1
Average	8.8	9.7	10.8	9.9

Source: Juwarkar (1991)

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Invited Papers:

FUTURE STRATEGIES FOR EFFICIENT UTILIZATION OF NATURAL RESOURCES TO SUSTAIN FARMING SYSTEMS IN INDIAN AGRICULTURE

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The welfare of human societies and the quality of life is direct linked to sustainable use of the natural resources. This has been duly recognized in Agenda 21, where it is stated that:

"Special attention should be paid to the demand for natural resources generated by unsustainable consumption and to the efficient use of those resources consistent with the goal of minimizing depletion and reducing pollution."

Maintaining the productivity of the asset base of agriculture through safeguarding the fertility of soil, adequate and timely access to water, preserving biodiversity and promoting agro-diversity are essential for sustainable agriculture. The asset base is destroyed not only through unwise physical interventions, but through biotic pressure from the rural poor and over consumption by a minority – hence equity in use of these natural resources is a precondition to sustainability, and eventually to stability. Unless there are conscious state interventions in all sectoral allocations to ensure that equity considerations and not merely technical parameters are incorporated in action plans, the ecological foundations for sustainable agriculture cannot be preserved. Farmers' well being requires ecological and livelihood security for the rural masses. Globally, the Right to Food and the Right to Water for all are increasingly recognized as requiring precedence at the state level overall other 'development' programmes.

ICAR Vision 2000 states : "Limited scope for horizontal expansion and need for increased crop intensity and productivity dictate sustainability of agricultural production through judicious exploitation of agro-biodiversity. Hence, germplasm collection, conservation, optimum utilization, and germplasm enhancement have to receive greater attention." Community stake through village/ panchayat level Agro-diversity Registers and rewards to communities preserving agro-diversity is therefore, essential. Fortunately, opportunities are available for this purpose under the already enacted Protection of Plant Varieties and Farmers' Frights Act and Biodiversity Act.

Natural Resource Management Systems with comprehensive land use and water systems planning, biodiversity conservation, forestry, agriculture, horticulture, livestock, aquaculture etc based on cross-functional and multi-level integration are essential for optimal use of the State's natural resources. Community level Participatory Resource Mapping, combined with scientific inputs such as Geographical Information System (GIS) and administrative integration at all levels, is needed for Resources Use Planning (integrating Land & Water Use Planning with Biodiversity Conservation). The proposed Agro-Ecology & Sustainable Livelihood Mission can work to promote this concept.

Conservation of biodiversity, bio-prospecting of wild species and valuable germplasm for bio-molecules, and genes for commercialization need to be documented at village/ panchayat levels as per requirements of Biodiversity Act. The Plant Variety Protection and Farmers' Rights Act should ensure similar village/panchayat level records for agrodiversity. Similar legislation is also required for livestock diversity. DNA fingerprinting is needed to establish ownership of indigenous materials, and IPR issues will have to receive priority to prevent misappropriation at all levels.

State should prevent soil erosion on hill slopes and improve hydrological cycles by involving communities, especially those on hill-slopes, in protecting and regenerating natural biodiversity in a way that meets local livelihood needs. Where biodiversity is already lost, agro-forestry and pasture management to meet Food-Fodder-Fuel needs of local communities can be promoted. Such activities can be undertaken under Food for Work and Employment Guarantee programmes.

State should avoid large scale interference with natural river flow and large scale use of exogenous water for monoculture, should sustain natural cycles, and should avoid depletion of ground water and degradation of soil and water from high input (water, energy, chemical pesticides and fertilizer) agriculture.

State should stop cultivated farming on sloping upper catchment areas and marginal lands; it should be replaced by suitable local & traditional varieties (grass, fruit trees, etc.) that can alternatively sustain the communities. This should be in accordance with land capability criteria and agro-ecological zoning. Special emphasis should be given to appropriate pasture management practices, improving forage production soil health maintenance and natural resource conservation.

State should take a policy decision in accordance with the ICAR Vision 2000 and make a policy shift and strategic switchover from crops requiring excessive water i.e. from Unsustainable High Energy & External Input Agriculture (UNSHEIA) to a Low External Input Sustainable Agriculture (LEISA) pattern by reverting to more of traditional cultivars and farmer-oriented practices. State should optimize irrigation to minimum necessary levels to maximum area and maximum number farmers.

State should phase out crops and varieties requiring unsustainable use of water. This will not only preclude drainage and water logging problems in irrigated areas, but bring to optimum productivity the 85% rainfed areas by giving access to at least the minimum essential water to the maximum area and farmers. Minimum necessary protective water made available to maximum possible area and maximum number of farmers will result in higher aggregate production for the State than focusing on increasing yields with high inputs to limited areas.

Genetically Modified (GM) plants/animals are receiving increasing scientific and consumer concern world-wide due to apprehensions of adverse impacts not only on human health but also on natural biodiversity, agro-diversity, sol microbiota, and livestock. GM strains should not be introduced without rigorous testing, public disclosures and debate, farmer evaluation and independent monitoring and control being assured by the State.

Action plan for phasing out of harmful pesticides and replacing these with traditional bio-pesticides and integrated pest control practices, needs to be urgently worked out and implemented by the state. Depletion of fossil fuel reserves, global trends and consumer and farmer well-being requires planned rapid transition to environmentally sustainable farming practices.

Departments for Ecologically Sustainable Agriculture – including Organic Farming & LEISA should be set up in all SAUs. These departments and KVKs should be geared up to provide effective capability building through education, training and support services at the work places. Natural Resource Management Systems based agriculture, integrating watershed and wasteland development, agroforestry, livestock management etc. within a framework of conservation of natural biodiversity, is a top priority for sustainable agriculture and should get reflected in the State's agriculture curriculum, research, education and training at all levels.

State should rediscover its vast heritage of indigenous seeds and preserve and propagate them through "Field Gene Banks" and "Seed Banks". As in the case of biodiversity conservation rewards, the National Gene Fund proposed under the Plant Variety Protection & Farmers Rights Act should be used to support rural communities/individuals who act as primary conservers by sacrificing personal gains for public good by cultivating traditional crops to maintain the genetic stock. Bio diversity Fund could also be used to support the local cultivators to revitalize *in situ* on-farm conservation traditions. Seed banks should ensure adequate choice for resource poor farmers who need to take into account not only yield per hectare but their capacity for cash input and risk taking. By taking up programmes for increasing biomass availability and preserving and propagating good indigenous seeds, the State could thereby also switch to low-input agriculture and reduce input costs and increase the use of traditional varieties better adopted to high risks marginal environments.

State should take measures to stop, phased over 5 years, all financial support which promote destructive / wasteful use of resources. Some of these subsidies promote wasteful resource use, depletion of ground water, increased use of toxic chemicals, loss of soil fertility and water purity and agro-bio-diversity. These financial resources should be redeployed to promote sustainable agriculture/livelihoods. Conservation of water and energy through differential tariff rates should be introduced at the earliest.

State should actively study the successful Organic Farming taking place in the state and elsewhere, and devise strategies for expanding this by providing support to labour and skill intensive biomass development, compost and vermicompost production at village level, preservation of indigenous seeds, small scale irrigation and non-chemical pest control systems. State should facilitate easy access to international certification of organic products to enable farmers to realize high prices both in national and international markets, support farmers through banks for bio-mass based dispersed industries, provide access to research and credit for agriculture, horticulture, livestock and processing.

State should redeploy irrigation resources to promote wider dispersal and equitable benefits from existing large projects and more actively promote small scale irrigation by integrating it with watershed development and with programmes for revival of traditional Water Harvesting Systems in villages. Equity in access to water and protective entitlements to the poorest sections should be precondition in planning and execution of all publicly funded schemes.

Introduce an environmentally conscious mind-set at every level, suitable incentives and/or network for marketing traditional crops and produce based on biodiversity and sustainable agricultural practices such as Organic Farming and LEISA should be introduced. To begin with, state should initiate action for awareness creation in agricultural universities, in related departments, at all levels of decision makers and in the general public, an awareness and respect for the richness of traditional organic agricultural practices and of the importance of conserving natural biodiversity, agro and livestock diversity.

State should take steps to shift current systems of measuring agricultural productivity from single species yield measurement to valuation of the total productivity, in terms of crop, fish and useful plants. Farmers in Maharashtra who have shifted to systematic Organic Farming of cotton, grapes, banana etc are stating that they have higher net yields, improved nutrition and health and greater diversity and sustainability. Their results need careful study and evaluations.

State should establish rural public distribution system (PDS) based on procurement and price support to a wide range of local cereals and millets, which are nutritious (Jowar, bajra etc). provide valuable fodder from residues, and thereby support the state's resource poor farmers.

Integrating all the above plans of action into one cohesive action plan for sustainable agriculture requires that the State develops an integrated plan for Agro-Ecological and Livelihood Security to ensure that ecological asset base essential for Sustainable Agriculture is not destroyed through the survival compulsions of the landless and impoverished sections of society for which some of the successful experiments could be replicated by the state in a big way.

Since capacity of ecosystems to support populations is limited, and is already breaking down under human population pressures, there is a need to make a demographic transition to low birth and low death rates as soon as possible. If human population continues to grow at unsustainable levels, sustainable agriculture will not be easy.

The only way to make sustainable land use operational, is the deep scientific and factual understanding of the biophysical System, more importantly of land and water the basic determinants of productivity in the primary sector. Hence, sustainable land use development requires a planning of approach in which ecological integrity is the governing factor and the permissible level of economic activity is the dependent variable.

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Issues of Efficient use of Natural Resource Management in Farming System

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Farming system is a way of life in vogue since ancient period in one way or the other to meet day to day needs of humans, animals and all the living beings forming an integral part of the same. Broadly a farming system involves dynamic integration of cropping (food grain, vegetables, fruits, forest and forages) and live stock (animals, birds and insects) with efficient management of natural resources to optimize productivity and profitability with due regards to off farm inputs of labour, fertilizer and credit. So long as natural resources namely land, water, vegetation were in abundance and used sparingly, management was never an important issue. However, new dimensions of rising human and livestock pressure and commercialization of agriculture induced over exploitation of natural resources disturbing their equilibrium with nature leading to reversible or irreversible degradation. Scarcity of natural resources and their diminishing output due to abuse or deterioration necessitate efficient management of NRM might require to be addressed at different levels.

There are local or micro level issues (like depleting ground water, air pollution near factories), meso level questions (air and water pollution in metropolis or in river valleys), national problems (deforestation and decrease in cultivated area per head or per household) and global challenges (e.g. the earth's atmosphere as a sink for green house gases and consequences of climate change phenomenon). This paper deals critically issues of efficient management of land, water and vegetation resources in context to farming system beginning at micro or meso level yet culminating to national or global scale, when adopted at larger scale.

Tangible benefits of main component of farming system like food, milk, meat, hides, fuel, fodder, fibre and wealth, though intrinsicly regulated by market, socio-economics and culture etc, are generally measured in terms of productivity and income. The intangible benefits and subcomponents relating to conservation with productivity that is the sustainability of system is often forgotton on account of quick economic gains. In fact integration of subcomponents of NRM in a farming system ought to be complementary, synergistic to optimize productivity addressing conservation issues and maintaining or upgrading natural resources for a healthy sustainable environment.

Land is the resources base, a store house for plant food elements, available water anchoring support to any kind of terrestrial matter and living being. Due to fast rising population, land to man ratio has been almost halfed from 0.34 in 1950-51 to 0.16 in 2002-03 per capita total cultivatable land has declined from 0.48 ha to 0.15 ha in the same period. Inspite of encroachment on sub-marginal and marginal land for cultivation, net sown area remain more or less constant. Enhanced cropping intensity and market driven crop diversification ignored principles of land use and ecology, which has threatened sustainability of land resource. The land degradation has also increased on these accounts which can neither be stopped nor reversed with fast pace of development. Conservation agriculture, diversification of agriculture, integrated management of resources, multiple use of water and recycling of farm wastes and residues seem only options to wisely manage land, water and vegetation resources.

Irrigated Agro-ecosystem (Indo-gangetic plains)

Shifting trends in cropping systems in irrigated Agro-ecosystem in Indo-Gangetic plains has been increase in area under rice-wheat at the cost of millets, pulses, maize, in kharif and barley and gram in rabi. The principle factor is market, economic gains and assured production without any regard to resource degradation. The major rice-wheat cropping system yielding 8.74 tonnes (net return Rs.26763ha^{-1}) estimated to consume 1650 mm water (PDCSR 2002) and rob the resource of 200 kgN, 50 kg P and 250 kg Kha^{-1}. The depletion of ground water, soil nutrients, organic carbon and micro nutrients cause stagnating or declining in productivity. Contrary to this pigeon pea-wheat with a yield of 8.81 (net return Rs. 33,194) consumes only 720 mm water requires less soil nutrients, needs promotion on all accounts. Incorporation of fodder sorghum and animal husbandry with recycling of cowdung manure must make a system more remunerative and sustainable. Conservation cropping sequences like groundnut-wheat (Rs. 36,794 ha^{-1}) followed by soybean-wheat (Rs.23,989 ha^{-1}) or rice-wheat (19,141 ha^{-1}) can safely replace un-economical and exhaustive rice-wheat in Jharkhand.

Multiple use of Water:

Water being a scarce commodity should be utilized in such a way that each drop is utilized for maximum production/ income. In IGNP command Diggi/ Khals are constructed to store water temporarily due to irregularity of canal as well as electricity. Besides using this storage for efficient irrigation, it can also be utilized for fisheries, earthworm manure, nursery, vegetable cultivation, horticultural crops, etc. The Diggi based farming system model developed by RAU provides huge income alongwith the income from farming system. The model is being popularized in Ganganagar and Hanumangarh districts having about 3000 diggis, which may provide about Rupees five crore income from fisheries only.

Multiple-enterprise options:

In irrigated areas integration of cropping with forestry, horticulture, dairying, poultry, piggery, duckery, bee keeping and seri-culture has tremendous scope to enhance productivity and income and improve quality of natural resources. A few examples are cited:

Table 1: Multiple-enterprise option

Tamil Nadu	Gross income Rs. ha^{-1}	Net income Rs. ha^{-1}	Additional income
Rice-rice-black gram	21717	8312	--
Rice-rice-cotton + maize + poultry-cum-fish	38219	17209	8897

Source: Shanmugasundaram *et al.* (1995)

Table 2: Economics of rice-based duck-cum-fish culture

Details	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	Employment generation (mandays)
Conventional cropping system (Rice-rice-rice-fallow-pulse)	25625	13790	252
Mixed farming system (Rice-rice-rice-fallow Cotton + maize and duck cum fish)	43185	24117	396
Additional income/ employment over conventional cropping system	17560	10327	144

Source: Ganesan *et al.* (1990)

Table 3: Economics of rice-fish-azolia farming (two years' mean)

Enterprizes	Grain yield (kg ha^{-1})		Fish yield (kg ha^{-1})	Net return (Rs. ha^{-1})
	Kharif	Rabi		
Rice-rice	5029	5071	--	15299
Rice-rice + fish	4784	4845	150	15587
Rice-rice-azolla + fish	4930	1940	163	16531
Rice-rice-calotropis-azolla + fish	5092	5033	173	17488

Source: Shanmugasundaram and Balusamy (1993)

Dryland Agro-ecosystems (Arid Rajasthan & Peninsular India)

The key determinant of cropping system in dryland region all over is water. Dependance on perennial vegetation such as grasses and tree fodder with animal components and its integration in farming system is time tested mechanism to combat drought or frequent crop failures in dryland region. For enhancing productivity a major shift in cropping has been replacement of low water requiring crops as well as application of more water to improve productivity. Inspite of the fact that micro irrigation systems like sprinklers in crops and drips in vegetables and fruit crops are being advocated there is very fast 1-12 m decline of ground water table in past two decades in Rajasthan, which is a very serious issue as the rate of recharge may be hardly 1/10th of the annual withdrawal. A survey (Narain & Amalkar, 2005) in arid districts showed that by the year 2000-01, 93% villages of arid region have been electrified. By 1980-81 about 200,000 wells were energized, while by mid nineties 450,000 (75% of total) got energized. By the end of twentieth century an estimated 3.72 million ha area of the state was under well irrigation in western Rajasthan accounting for 36% of the total. Farmer has started feeling pinch by lowering boring and spending on power. Now, more than 60% blocks in the state are over exploited and the number of safe blocks is on steady decline. Even in IGNP Command fight by the tail-enders is becoming a common feature. A very precarious situation is emerging which has to be stopped or reversed. Traditional systems of water harvesting in ponds, nadis, khadins, tanka, anicuts and roof top water harvesting for drinking of animals and household will go a long way in meeting small demands and recharging ground water.

Crop Diversification:

The situation warrants reverting back to low water requiring short duration crops like moth, guar, pearl millet, and intercropping of pearlmillet + pigeonpea, fodder crops and soybean, groundnut and sesame in kharif in better rainfall region. Taramira, mustard, gram and barley after kharif fallow are ideal option. The limited available water be reserved for crop diversification for cash crops (Cumin, Coriander, Fenugreek, Isabgol etc.) or vegetables and arid horticulture.

Agroforestry a viable option:

Agroforestry with fodder/ multipurpose trees and grasses and integrating animal component on range lands/ silvipastures is time tested, least water demanding and resources agradation system ideally suited for arid and semi-arid drylands. Earlier we adopt better it is. This will also build up tree cover on outside forest and reduce buildup of GHG in atmosphere. With tree component there will be build up of organic carbon (Table 4) and improved soil physico-chemical conditions.

Table 4: Changes in soil properties (2-30 cm) under different tree crops combination in 5 years:

Land Use	O C%	AV.N. Kg/ha^{-1}
Crop based system	+0.07	+10
Eucalyptus based system	+0.12	+20
Acacia based system	0.20	+31
Populus based system	0.17	+25

Source : Singh *et al* (1997)

Ideal for Wasteland and Animal Resources:

Wasteland mapping of Rajasthan reveal about 30% geographical area are wasteland. These can ideally be converted to silvipastures. The state particularly the arid western Rajasthan has vast animal population. The ratio of animal : human in Rajasthan is > 1.0

and western region it may vary 3 to 5 : 1 against only 0.5 : 1 in rest of the country. The situation ideally matches with plenty of wasteland. Animal based farming system should get priority in arid and hyper-arid region over crop based farming system. Tree based farming system shall improve organic stock and soil fertility as well as microbial biomass etc.

In arid region CAZRI (2002) tree based farming system gave always higher BC ratio compared to crop based system (Table 5). Shifting to spices and condiments medicinal and aromatic plants like Henna, Senna, Guggal which are low water demanding with further improved C : N ratio and better income of farmer.

Table 5: Benefit cost ratio of land enterprises

Farming System	B.C. ratio*
Agroforestry	1.69
Agro-Horticulture	1.46
Agri-pasture	1.87
Silvi-pasture	1.66
Crop production	1.24

* At 20% discount rate

Source: CAZRI unpublished

Conclusions:

Efficient management of natural resources requires integration of cropping system with animals invoking recycling of crop residues and animal wastes while targeting optimization of productivity. The over-exploitation of water, land and vegetation should be avoided to maximize productivity/ income, which can be achieved by crop diversification, introducing animal component, organic farming and value addition etc. Multiple use of water as well as multi-enterprise farming system are viable option to enhance income and safeguard natural resources.

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View of Panalist:

Dr. Vijay Mehta, Vice Chancellor, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli presented his views by presenting a paper on

IMPACT OF GLOBAL ORIENTED CIVILISATION ON INDIAN AGRICULTURE

The global agriculture in the 21 century is dominated by a small group of economically active population in agriculture from North and Central America (2.77%), South America (6.36%), Europe (3.50%) and Oceania (2.99%). Further, dependence on agriculture is on the decline (48.9% in 1990 to 43.1% in 2004) and the agricultural production is characterized by highly intensive, mechanized, productive and cost effective. Ever-increasing population (78 million addition every year) with more rural exodus coming to urban areas (now 3 million in urban areas which would rise to 5 billion by 2030 in world) and ever expanding industrialization have been exerting tremendous pressure on natural resources causing ecological imbalance. The demand for food is increasing both quantitatively and qualitatively and is diversified in nature. The revolution in information technology and telecommunication has made the global agriculture more knowledge intensive and highly competitive.

This global scenario of agricultural production and trade has multidimensional impact on Indian Agriculture. This requires to gear up and reorient our agricultural production to suit to changing demand driven scenario.

Threat to small farmers:

resources viz; land and water. In India, during the last half century, per capita available cultivated areas is reduced by 50% and is now 0.16 ha. Similarly, water availability for agriculture is considerably reduced due to increasing demand for other sectors. In 2000, the annual waste souse for irrigation was 541 bcm (85%) which would rise to 910 bcm (83%) by 2025. It is also stated that 28% of the districts in the country receive rainfall less than normal and 60% of the areas is rainfed t is also a matter of great concern that out of the total geographical areas, 174 million ha (53%) is degraded and problem area. It is therefore, challenging task before the Indian farmers to increase substantially productivity, from shrinking, improvised finite natural resources so as to complete in the international trade.

Ecological security:

Due to burgeoning population, urbanization and industrialization, ecosystem is endangered. Air and water pollution problems are common. Land degradation, floods, cyclones, earthquake, drought, tsunami, land slides, etc are frequently observed, causing heavy toll, loss of property and crops and damage to cropped area. Global warming is considered to be one of the causes of there natural disasters and ecological disturbances. It has been estimated the total carbon emissions is 7093 m tones in 2005 of which Indian shared 350 mt. It is projected that in Indian the total carbon emission would rise to 490 mt by the year 2015. The area under forest is 22.8% of the total geographical area which is less than the minimum requirement of 33% as per national policy. Indiscriminate deforestation, forest first both intentional or spontaneous and shifting cultivation have endangered biodiversity. It has also disturbed the food chain and has been causing threat to human life. In view of this, ecological security should form the priority area of attention for well being of human beings.

Cost effective production strategy:

In total production of food grains and oilseeds, horticulture milk and fish, we have made spectacular progress and achieved high rank in world agricultural production scenario. However, as far as productivity is concerned, we are at a very low position. In most of the production areas, we have attained the production about 50% of the world average.

India ranks 2nd, 1st, 2nd, 1st, 4th and 3rd in total available land, irrigated area, economically active population in agriculture, livestock population, implements (tractors in use) and total fertilizer consumption, respectively. Besides, we have made significant progress in agricultural production technology. In spite of the these strengths, we have not achieved breakthrough in increasing productivity, the reasons being large number of unorganized small farmers, poor input delivery system, poor input use efficiency, high rate of illiteracy (35% overall and 45% in females), poor socio-economic conditions, very weak proactive advice in farming, illorganised farming system approach, etc. these issues need to be addressed in right perspective to augment agricultural production and make it more cost effective.

Diversified agriculture

In India there are 15 agro climate zones having temperate to tropical climate and different soil types. This unique agro climate diversity offers vast scope to grow a variety of crops and fruit crops without much investment on poly houses or green houses. It is therefore, required to identify non-traditional areas, preparation of location specific cropping pattern and effort intensification in potential areas with greater emphasis on cash and non-cash inputs. The production should be oriented to meet domestic and global needs based on market survey.

Shift from chemical intensive agriculture to organic farming

There is growing health consciousness at global level which has led to increase in demand for organic food. There was sevenfold rise in organic market from 1992 to 2002 (3.4 billion dollar to 21.6 billion dollar). Different countries have formulated favorable policies to promote organic agriculture. However, in India, organic agriculture is just a beginning (75000 ha) and is mostly confined to horticultural and plantation crops. In fact, that offers good scope for organic production as the chemical use in far below the recommendation level as compared to other countries. Further, organic manure can be available in large quantity. Annual production of municipal solid waste, municipal liquid waste, food and processing waste and dairy industry waste is 30 mt 438 billion lit, 4.5 mt and 20 billion lit, respectively. Their processing and recycling for agricultural production is necessary. Annual production of compost is 1389 mt. This necessitate identification of potential areas for organic agriculture, certification, special production campaign, packaging, processing and marketing.

Proactive advice

It is the era of information technology and hence, proactive advice to farmers based on weather forecast, market information and management information in necessary to protect the farmer from vagaries of nature and market fluctuations. Establishment of weather forecast centers network, remote sensing facilities, market intelligence centers agribusiness centers, internationally acceptable certification centers, etc. are needed for effective and need based agricultural production and in turn, for economic survival, of the farmers.

Contract farming

Farmers in the country find difficult to mobilize resources and increase productivity due to small and fragmented land holding. Under this situation, contractual farming by retaining rights of land owners may be thought off. This would attract private investment, corporatization of inputs, custom hiring of services and marketing. This would also help solve problem of fallow and wasteland and would help increase agricultural production.

Import-Export Policy

Our first priority is to develop unrestricted, unified national market for farm produce within the country. Agricultural export be restricted to only those commodities which are surplus and will have competitive edge in the world market by identifying market areas and widening product base. At present, agriculture accounts 10.95% (Rs. 498029 million) of the total national export (2005-06) which shows 50% decline during the last decade. In total agricultural export, agricultural products account to 92.39% and horticultural products share 7.61%. the country is emerging as the major horticulture producer which provides tremendous opportunities for increasing export of processed horticultural products. It is also mentioned that import of forest products is more than export. Infect, our country has rick heritage of use of herbal medicines and is the treasurer of medicinal plants which needs to be exploited to earn foreign exchange. This requires technology back up, infrastructural support, promotional measures, increased investment in power (present electricity consumption is 22.93% of total and is on the decline and irregular), transport, telecommunication, etc.

The import of agricultural commodities accounts to 3.33% (Rs. 210255 million) of total national import which shows decrease over the last decade. The loss of foreign exchange is more on import of pulses, oilseeds and vegetables oils. This necessitates to increase our production of pulses and oilseeds. It is noteworthy to state that in Philippines and Mexico, millions of maize growers became jobless by large scale imports of highly subsidized maize from US. In India also, import of cheaper oilseeds decreased domestic production of oilseeds by 25% in 2000-01. This requires a suitable strategic plan to discourage import and increase domestic production.

National policy on agriculture:

At present, Indian agriculture is in emaciated form as compared to highly nourished agriculture in developed countries. Total amount of subsidy given by Canada, EU, USA, Japan and OECD countries in 2003 was $ 605 million, $ 118028 million, $ 35618 million, $ 47874 million and $ 256752 million respectively. This subsidy is given under different categories viz, Amber Box, Blue Box, and Green Box and is many times more than that given to Indian farmers. In India, compared to farming, more subsidy and other promotional benefits are given to industries. Further, inputs are provided at cheaper rates and there is also no transparency in following WTO agreement by developed countries. They impose heavy tariffs on imports. Besides, check on import of produced is provided through rigid quarantine measures and points defects in produce. The farmer in the developed countries is protected from crop failure by direct deficiency payment by taking at last three years average and considering minimum support prices and market price. We have not yet fixed minimum support price for horticultural produce which is utterly needed to avoid distress sale. Out policy an agriculture must include issues to safeguard the interest of farmers.

The above facts put us in dilemma whether our agriculture can withstand global changes? The answer is affirmatory. It is our experience that our agricultural production system is the most flexible and acts as buffer to absorb any shocks and odds. It has come out from begging bowl stage and has achieved self sufficiency and maintain buffer stock to with stand unforeseen disasters. It has been nourishing teeming millions and providing work to large chunk of population. It has also vast potential to increase production and productivity and can keep pace with changing global scenario. We large land area for arable farming, irrigation potential, manpower, expertise, technology, diversified ecosystem, etc. There resources can be mobilized through strong input-output linkages. Inputs refer to Govt. Policy support, agril. inputs delivery, credit supply, infrastructural facilities, proactive advice, improved technology etc. The output refers to demanddriven quality production and feed back for research and development from farmers.

Repporteears:

- Dr. A.K. Singh,
- Dr. Chattopadhyay,
- Dr. Atul Kumar

Welcoming Dr. Mangala Rai, Secretary, DARE and DG, ICAR before the Plenary Session

Plenary Session of 32nd IAUA Vice Chancellor's Annual Convention

TECHNICAL SESSION-VII

Bio-component models for integrated farming system

Chairman: **Dr. S.S. Baghel,** Vice Chancellor, AAU, Jorhat

Co-Chairman: **Dr. N.L. Maurya,** Vice Chancellor, RAU, Pusa

Invited Papers: No paper was presented in this session.

View of Panalists:

Dr. B. K. Kikani, Vice Chancellor, Junagadh Agricultural University, Junagadh expressed his views by presenting a paper on

BIO-COMPONENT MODELS FOR INTEGRATED FARMING SYSTEMS

Farming system is a resource management strategy to achieve economic and sustained production to meet diverse requirement of farm household while preserving resource base and maintaining a high level environmental quality. Integration of various farm enterprises in a farm ensures growth and stability in overall productivity and profitability. It also ensures recycling of residues, optimization of resources, minimization of risk and generation of employment. Various bio component that could be included in farming system are crops, vegetables, fruits, flower cultivation, dairy, poultry, fish, goat, pig sericulture, mashroom cultivation, agro forestry, bee keeping, silviculture, agro based industries and food processing. A Judicious combination of bio-components complementary to cropping and suited to the given farm situation and farmer's preference would bring overall prosperity. In agriculture, crop husbandry is the main activity. The income obtained from cropping is hardly sufficient to sustain the farm family throughout the year.

Choice of enterprise:

The basic points that are to be considered while choosing appropriate enterprise in integrated farming systems (IFS) are:

1. Soil and climate features of an area locality
2. Resource availability with the farmers
3. Present level of utilization of resources
4. Return/ income from the existing farming system
5. Economics of proposed integrated farming system
6. Farmers managerial skill
7. Social customs prevailing in the locality.

Crop production

Cropping system based on climate, soil and water availability have to be evolved for realizing the potential production levels through efficient use of available resources. The cropping system should provide enough food for the family, fodder to the cattle and generate sufficient cash income for domestic and cultivation expensive. Intensive cropping include multiple cropping and inter cropping.

Alteration of crop geometry may help to accommodate intercrops without loosing the based crop population.

Live Stock Production

Livestock is the best complementary enterprise with cropping, especially during the adverse years. Installation of a biogas plant in crop-livestock system will make use of the waster at the same time provides valuable manure and gas for cooking and lighting. In a wetland farm there are greater avenues for fishery, duck farming and buffalo rearing. Utilizing the rice straw, mushroom production can be started. Under irrigated conditions, inclusion of sericulture, poultry and piggery along with arable crop production is an accepted practice. The poultry component in this system can make use of the grains produced in the farm as feed. Pigs are the unique components that can be reared with the wastes which are unfit for human consumption. In rainfed farming, sheep and goat rearing form an integral part of the landscape. Sericulture can be introduced in rainfed farming provided the climatic conditions permit it Agro-forestry (Silviculture and silvi-horticulture) are the other activities which can be included under dry land conditions. In the integrated system, selection of enterprise should be on the cardinal principle that these should be minimal competition and maximum complementary effect among the enterprises.

Animal husbandry sector provides self employment to millions of house holds in rural areas. Rural women have a special place in the animal husbandry sector, in which they play a very prominent role. Women constitute 71 % of the force in livestock farming. In dairying alone, 75 million women are engaged as against 15 million men.

Livestock enterprises with crossbred cattle and high yielding buffaloes have shown to be a remunerative business mainly on account of the sale of milk produced at these farms. Studies have shown that dairy enterprises as against crop raising or production in rural areas, gave larger profit margins in marginal, small and medium holdings. Studies have also shown that dairying and crop production together for small farmers having irrigated land was more profitable than crop farming alone. In India because of the low per capita availability of land, the crop based rural economy needs to be diversified or converted tin to a livestock oriented, mixed farming system for rapid economic development, income generation, poverty alleviation and providing employment to the rural masses.

Use of cow urine as insecticide and pesticide in agriculture crop :

Organic farming concept has promoted the use of cow urine in combination with Neem and other herbs as a effective pesticide and insecticide in agriculture crop production. At the same time, it discourages the use of deadly chemicals as a insecticide and pesticide. There by reducing the cost of cultivation and also reduces the possible health hazards. Clean and chemical less food grain production fetches more price which is possible through the use of livestock waste.

Medicinal properties of the cow products – Panchagavya are freshly gaining importance. However the scientific claims made against the healing properties of the products needs to be assessed in the scientific background.

Advantages of livestock-agriculture integration model:

1. It reduces use of wood as fuel, thus checks deforestation
2. It improves air quality and reduce acid deposition.
3. Improve environment and human health.
4. It improve Soil quality in terms of fertility and reduce erosion.
5. It improves crop productivity by replcing soil deficient ingradients.
6. It reduces use of chemical and synthetic fertilizer.
7. It is a alternate dependable source of energy.
8. It helps to check spread of weeds by way of fermenting seeds of weeds passed through dung.

It is now well established that animal husbandry sector shall continue to be an important component of growth of agriculture economy for the reasons as:

(1) Sustained growth in per capita income, urbanization and awareness about nutritional rich animal based foods.

(2) Rural households with little or no land, look for apportunities in no land based or less land based enterprise.

(3) Lower input cost and cheap labour being asset to livetock agriculture integration, would promote growth in trade related field.

Aquaculture

The integrated fish farming is the horizontal integration or diversification of agriculture with the development of a fish farm and as a sub system on a farm with existing crop or live stock subsistence. Integrated fish farming is well developed in China, Hungary, Germany and Malaysia, and is accepted as sustainable form of aquaculture and major contributor of farmed fish. Freshwater aquaculture in India is organic-based and derives inputs from agriculture and animal husbandry.

The different types of integrated fish farms may vary considerably and they may be grouped into the following major categories.

1. Fish - crop - plant integration
2. Fish - live stock - poultry integration
3. Fish - live stock - crop integration

Poultry management

In fish-poultry integration, birds may be housed in intensive, semi-intensive or extensive systems. Intensive system of bird rearing is considered best for integration with fish. Poultry shed is constructed in such a way that bird droppings are directly added to the pond water. This facilitates the purpose of manuring the pond water automatically. Generally bird-shed is constructed on the dyke on raised platform over pond. Birds are stocked @ 500-600/ha with the floor space of 0.3 m^2 / bird.

Benefits

- The poultry manure acts as an excellent pond fertilizer and increases biological productivity. No supplementary feed and fertilizers are required. This saves about 60 to 70 % of the cost of fish culture.
- The pond embankments provide the space for construction of poultry house and thereby allowing maximum use of space.
- Integration helps to keep the poultry house clean.
- It ensures high profit through less investment.

Integrated fish – cum - duck culture

A fish pond provides an excellent disease-free environment for ducks. Ducks consume juvenile frogs, tadpoles and dragonfly, thus making a safe environment for fish. Duck droppings go directly in pond, which is a rich source of carbon, nitrogen and phosphorus. This stimulates growth of natural food organisms in pond water.

Production

Fish yield of 3000-4000 kg/ha/year is expected. In addition, eggs and duck meat are also obtained in good quantity.

Integrated fish - cum - live stock – cum - agriculture

The integration of aquaculture with livestock and crop farming offers great efficiency in resource utilization, reduces risk by diversifying crop, and provides additional food and income. This system involves recycling of waste or byproducts of one farming system as an input for another system and efficient utilization of available farming space for maximum production.

In composite agro-fish-livestock culture system, the water body where fish is cultured can receive live stock excrement (both liquid and solid) as organic fertilizer and wheat bran, rice bran, maize bran and soybean products, which are readily available on the farm itself, serving as food for fishes under culture. At the same time, the pond water can be used for agriculture and horticulture irrigation purpose.

Integrated fish - cum - sericulture

Sericulture is an agro-industry and plays a very important role in rural economy of India. The industry provides ample work for women in rural area in rearing silk worm. The waste products from sericulture practices could be used as nutrient input in fish ponds. Mulberry trees grown on pond dykes serves as producer, upon which silk worm acts as first consumer while fish is the second consumer in fish integration.

Dr. N.L. Maurya

- Models needs to be modified as per availability of land to farmers in IFS.
- Eco-village concept should be popularized.
- Location specific and need based model should be developed for IFS.

Dr. A.S.Ninawe, Vice Chancellor, Maharashtra Animal & Fishery Sciences University, Nagpur also expressed his views by presenting a paper on

BIO-COMPONENT MODELS FOR INTEGRATED FARMING SYSTEMS

Indian economy is based on the agriculture over the decades with around 25 per cent of the farming population of the world and over 80 per cent of them belong to the small and marginal farming categories i.e. having less than 2 hectares of land per capita. The total number of rural households in the country is expected to increase to 153 million by 2009-10. Thus, majority of the Indian population is still dependent upon agro-based business for their livelihood. However this business has several bottlenecks. Decreasing landholding, irregular rainfall, crop diseases, low market prices to the commodity, transportation and storage deficiencies, drought and several other factors have made this major rural business vulnerable. The Animal husbandry and dairying business has been looked as the secondary business since long. However, now the time has come to review this approach for overall growth of the economy. The concept of Mix Farming System is now coming up for the overall development of the farmers. The SWOT analysis is required to be done for bringing about total metamorphosis in the agriculture and livestock sectors. The current need is to highlight and demonstrate how in the future the production and processing of our biological resources can be performed in a sustainable and rational manner.

Agriculture, Animal Husbandry and fisheries are hugely important economic and social sectors in India. The exports derived from these sectors alone in India are worth around 498029 million a year employing around 60-70 per cent of the total population of the country. Thus composite use of these resources is the need of today for overall improvement in the economy of farmers.

Liberalization of Indian economy and globalization of marketing of Indian products have brought about an unprecedented opening for a paradigm shift in respect of livestock sector. It has also thrown up formidable challenges in restructuring our production and marketing strategies to meet the changing criteria and parameters, which determine the direction and rate of growth. India produces about 100 million tonnes of milk, 4.45 million tonnes of meat, 45 billion eggs and 6.5 millions of fishery products in a year and is justifiably recognized as one of the leading producers of livestock and fishery products in the world. Currently, India is one of the top five global destinations for agricultural and agro-based retail investment with more than 21 million people employed in this sector, which contribute 13 per cent of the nations GDP. The animal husbandry and fishery is largely perceived as a secondary income generating business and has traditionally remained in the unorganized sector in India. Integrated Farming of agricultural and agro-based products may help bring about a quiet transformation in the country's moribund farm sector by attracting private investment to improve production, productivity and quality. However to exploit these to the fullest extent, the key concerns need to be addressed are strategic selection of components of mix farming, technical know-how, marketing, and inventory management. The value addition along the supply chain may in fact increase income and employment opportunities for farmers.

The farmer having average resources can think of small-scale Integrated/Mixed Farming models such as Agriculture-Livestock; Agriculture-Aquaculture (IAA) or any suitable combinations depending upon the biocomponent availability. Integrated Agriculture-Aquaculture (IAA) offers special advantages over and above its role in waste recycling and its importance in encouraging better water management for agriculture and forestry. the combinations such as dry-land crops and fish culture, sometimes with a small input from chickens or other livestock; wetland crops like rice and fish culture; integrated animal and fish farming e.g. pigs, ducks, chickens farmed together with fish. (e.g. pigs/ duck/ chickens farmed together with aquaculture) or sewage fed fish culture can be the options with the farmer depending upon his resources (Fig. 1).

India can also boast a great deal of global success in terms of efficient food production and farming systems to support more sustainable agricultural practices. Thus we need to target research for developing knowledge and technologies for the sustainable production and exploitation of biological resources, covering the whole production chain, and taking into account the competitive international context and ways to adapt to the evolution of the common agriculture, Animal Husbandry and fisheries policies. The Mix Farming System needs to be adopted to utilize the bioresources to their maximum and to compensate the losses if any in one or the other business. The emphasis should be focused on sustainable agriculture and animal production systems, aquaculture systems, the exploitation of the bio-refinery concept and the integrated production chain method and to develop Industrial products such as green chemicals, bio-polymers and bio-fuels from biological resources.

The ultimate goal of Mix Farming System is towards the overall rural growth. The development of Biocomponent models influencing technological and socioeconomic changes; multifunctional land use and management shall continue to be a boon for the overall development of the agriculture sector. To have a sustainable development, a boicomponent model is suggested in the figure for the holistic development in the rural areas. The proposed model can be adopted nationwide for agrifarming, diversification of agriculture towards non-food grain and high value commodities as a potential income augmenting, employment generation leading to nutritional security through its demonstration in different agroclimatic and socioeconomic environment. Such models can be successfully adopted based on the bioresources available in the area.

Repporteears:

- Dr. A.K. Singh,
- Dr. Chattopadhyay,
- Dr. Atul Kumar

TECHNICAL SESSION-VIII

Improvement in the standard of research (with Basic & Applied).

Chairman: Prof. M.C. Varshney, Vice Chancellor, AAU, Anand

Co-Chairman: Dr. K.R. Koundal, Joint Director, IARI, New Delhi

Invited Papers:

Standard of Applied Research – Improvement and Concerns

S. K. Sanyal & R.K. Samanta

Prologue

Dr. Sanyal is Director of Research and Dr. Samanta is Vice-Chancellor, BCKV, Mohanpur, Nadia, West Bengal – 741235

Basic research is important, it is a cultural necessity. Any civilized country must provide an opportunity for its highest intellects to work on problems of their choice. The basic research refers to the study and research in pure science that is meant to improve and enrich our scientific knowledge base. Such research is often purely theoretical with the intent of improving our understanding of certain phenomena, *albeit* many a times *without* offering solutions of the problems (Kendra Van Wagner, http://psychology.about.com). It appears that the data generated from the basic research constitute the pillar on which to achieve the success of applied research. Frontier areas of basic research are often decided by the technology imperatives of developed countries. They have already reached a high level of technology development, often with the objective of reaching even higher technology levels. Of course, there is no denying that we in the developing countries ought to also pursue such research, if not for anything else but as investment for future, or, if possible, even for current- technology development.

Applied research, on the other hand, refers to scientific study and research that seeks to solve practical problems. Applied research aims at arriving at the solutions to everyday problems and developing innovative technologies. Applied research is also necessary to catalyze indigenous technology growth. For such research, the spatial and temporal relevance has got to be emphasized. The problems of this country, a developing country, are of quite different nature and dimensions as compared to those of the countries which have already attained a measure of success in improving the quality of life of their people. Research in Agriculture is no exception. Indeed what is of grave concern today in

India need not remain equally pressing tomorrow. Hence the areas and the intensity of applied research change. This warrants regular review of the requirement of applied research for any mid-term corrections. Furthermore, certain issues need sustained attention compared to others which are essentially of short-term nature. The thrust area of applied research ought to have an in-built adjustability to reorient itself for responding appropriately to such fine-tuning.

Basic Terminologies

We propose to deal in little details with the terminologies which are of relevance in respect of the title of this article.

'Research' for the purpose of the Research Assessment Exercise (RAE) is to be understood as original investigation undertaken to gain knowledge and understanding. It includes work of direct relevance to the needs of commerce, industry, and to the public and voluntary sectors, the invention and generation of ideas, images, performances, artifacts including design, where these lead to new or substantially improved insights; and the use of existing knowledge in experimental development to produce new or substantially improved materials, devices, products and processes, including design and construction.

Research and experimental development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications. R&D is a term covering three activities: basic research, applied research and experimental development [Frascati Manual (http://www.oecd.org/dsti/sti/stat-ana)].

Basic Research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.

Applied Research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

These activities are exemplified as follows:

A) The determination of the amino-acid sequence of an anti-body molecule would be basic research. Such investigations undertaken in an effort to distinguish between anti-bodies of various diseases would be applied research. Experimental development would then consist of devising a method of synthesizing the anti-body for a particular disease, based on the knowledge of its structure, and clinically testing the effectiveness of the synthesized anti-body on patients who have agreed to accept experimental advanced treatment.

B) Theoretical investigation of the factors determining regional variations in economic growth is basic research: however, such an investigation performed for the purpose of developing governmental policy would be applied research. The development of operational models based upon laws, revealed through research for the modification of regional disparities, would be experimental development.

The research on the application of technology in government is wide and varied. As a consequence, it is difficult to summarize in simple terms. Any given thread of research may have multiple facets: technologies, programme areas, policy threads, management issues — and placing a piece of research into a given category ignores the complexity of the research.

ICAR and Its Catalyzing Role

The ICAR has played a pivotal role in developing agricultural technologies, input material and critical scientific base leading to self-sufficiency in food. Efforts have been made to provide fresh thrust to organizational and systemic reforms of ICAR through rationalization of manpower strength, commercialization, public-private linkages, exchange programmes, etc. Agriculture (as in our country) is not only a country's backbone of food, livelihood and ecological security systems, but is also the very soul of its sovereignty (Raman Nair, 2004). To achieve sustainable advancement in quality of human life, meeting the domestic food requirement is to be given foremost priority in developmental plans. As shrinkage in cultivable land per capita and steep growth of population is going hand-in-hand in this country, without showing perceptible trend of improvement, growth in food production is to be achieved by qualitative improvement in farming. This requires improvements in material inputs, farming techniques, storage technology and research. Effective integration of these factors is tied closely to adequate information flow, which can be ensured only by an efficient information system for agricultural education, research, extension and development. So evaluation and improvement of existing information services is very crucial for sustainable agricultural growth. Preparation of different sets of questionnaires and the way of conducting interview schedule is one of several means for improving standard to elicit information for applied research. Agricultural research carried out at various institutions in the region at huge public expense has generated knowledge and database for improving production. It is, of course, a different question as to the ready accessibility of such information in time and space to the targeted end-users. One can not but desire appropriate intervention to ensure the latter. Indeed the agricultural sector appears to fall short of effectively banking on information resources available due to the lack of an information system and network in place. Thus, there is a need of having a model plan for a computer communication network for resource sharing between the agricultural institutions in the states as well as the Central Government sector and the Public domain which will also ensure, among others, a smooth flow of research findings down to the grassroots level to achieve maximum productivity in agriculture. Rural development-related technologies must be given the highest priority. After all, the two-thirds of the Indians live in villages. Increase in agricultural productivity through the use of known science and technology interventions is the need of the day, especially in the poorest of the rural parts of the country. To realize the desired turn-over in the agriculture productivity, job opportunity in the agro-based small and cottage industries has got to be generated and/ or augmented *in situ* which may help in arresting the alarming trends, apparent presently, of migration from the farm sector to urban areas. It is indeed heartening to note that this is already being attempted (e.g., during the X-th Plan), for instance, the value-addition by food processing.

The concept of evidence-based policy making is now a standard of best practice in the Government. Increased public scrutiny and accountability has created a heightened awareness of the need for politicians and decision makers to have a range of evidence to support policy development and decision making in the public sector covering agriculture. Much of the data for this study originate from health and social care perspectives; agriculture is yet to receive adequate attention in this regard. However, it is likely to be of interest to policy makers and practitioners in health, social care and other areas of public sector service delivery with an interest in integrating evidence into practice.

Applied and Action Research: Key Study Findings

Many public service systems are 'data-rich, but knowledge poor'. There is a need for a more nuanced and broader understanding of what we mean by evidence to include the experience and wisdom of staff at all levels. This presents many challenges to organizational and professional cultures. The emergence of action research can be seen as a response to this research-into-practice dilemma and growing dissatisfaction with traditional approaches to research. (http://www.scotland.gov.uk/socialresearch September, 2005).

Rethinking on Research and Evaluation

There is a need for greater acceptance and understanding of the validity of qualitative research, particularly in generating data for improvement. Related to rethinking evidence is the need to develop a different understanding of the scope for evaluation to provide opportunities for learning and generating real-time feedback and to build individual and organizational evaluation capacity. Research finders need to underpin this by greater degree of support for interdisciplinary research to promote understanding the human dimensions of change and to redress the focus on the technological and scientific evidence. (http://www.scotland.gov.uk/socialresearch September , 2005).

The Importance of Knowledge Brokerage and Mentoring

Evidence 'doesn't speak for itself'; it is clear that evidence take-up needs *facilitation* - it is this, not the strength of the evidence that affects implementation. Facilitation includes the brokerage of evidence at a strategic level and mentoring or support for individual learning and reflection. There are a number of examples of approaches and methods to facilitate take – up of evidence into practice by using action research and applied research. There is a spectrum of approaches that cover a range of perspectives from the 'evidence into practice' or using evaluation evidence interests, to a variety of different approaches to action research. (http://www.scotland.gov.uk/ socialresearch September , 2005).

Human Resource Inputs and Infrastructure

It is undenying that the standard of research, be it basic or applied, would depend upon the quality of input. It goes without saying that the latter depends to a to provide adequate and quality infrastructure to foster such research skill to ever increasing heights. This is all the more important in the context of global competitiveness in regard to the quality of the deliverables that matter, especially in the field of agriculture, not to speak of the other allied fields.

Public-Private-Partnership (PPP)

In order that the findings of applied research reach the projected beneficiaries, an optimum mix of public and private enterprises is a must in the current context. Indeed, the public resources may be limited, and there may be many takers of the same, whereas the private enterprises ought to be willing to discharge their societal obligations in ensuring that their existence is not only in the interest of the individual or the corporate sector, but also that for the service of the community at large.

Trends of Applied Research: Concern for the Country's Agriculture

Coming to the present day agriculture in our country, the introduction of high yielding crop varieties in intensive cropping, coupled with greater use of NPK fertilizers, generally free of secondary and micronutrients, in the irrigated areas caused widespread deficiencies of these micronutrients throughout the country. Thus, the analysis of a large number of soil samples from different nutrient deficient areas of India revealed in the recent past the predominance of zinc deficiency in divergent soils. Introduction of rice-wheat cropping system has also caused emergence of Fe and Mn deficiency from initial 2-4% to presently 20-22% level. While combating such problems, information on response of micronutrients like Cu, Fe, Mn, and B in combination need to be generated. Systematic studies using GIS would be useful for monitoring and delineating micronutrient deficiency in different cropping systems and soils, unattended so far, for suggesting the economic use of fertilizer with improved fertilizer-use efficiency.

Soil nutrient supply, fertilizer efficiency, and productivity are known to vary widely across small distance in the fields. At present, however, blanket fertilizer recommendations are often practised over large areas without taking into account the wide spatial variability and site and season-specific crop nutrient requirements. This helps to explain why fertilizer nitrogen (N) use efficiency is usually poor, the use of potassium (K) fertilizer is often not balanced with crop requirements and other nutrients, and as a result, profitability is not optimized. Future strategies for nutrient management in intensive cropping system ought to be more site-specific and dynamic to manage spatially and temporally variable resources based on a quantitative understanding of the congruence between nutrient supply and crop demand. Indeed, the question that arises now is where one goes from such concepts like targeted yield, soil test recommendation and site-specific nutrient management (SSNM) for efficient and balanced use of plant nutrients. The SSNM requires intensive soil analyses within individual fields in order to construct crop- and soil-specific nutrient recommendation. This provides a major challenge considering the fragmented land holdings in the country as well as the existing soil testing infrastructure. Geo-statistical analysis and GIS-based mapping effectively counters that challenge by providing an option to create soil fertility maps of large areas through interpolation of soil analysis data from a small number of samples. Such dynamic maps would provide an opportunity to assess variability in distribution of native nutrients across a large area and thus aid in strategizing appropriate management of nutrients leading to better yield and environmental protection. This would facilitate adoption of what goes by the term **Precision Agriculture**.

Furthermore, as far as the biodiversity is concerned, inefficient use, overuse and abuse of fertilizers caused considerable ecological loss to the nation and the farmer. While the elevated nutrient levels may prove advantageous to many species, the same levels may become deleterious to several other species leading to their disappearance from the ecosystem, thereby disturbing the ecosystem equilibrium. Inorganic fertilizers, particularly nitrogen compounds, can cause significant changes in species composition by increasing the dominance of a few species with an overall loss of species richness. It has been observed that the addition of phosphorus (P) in the absence of nitrogen (N) encourages particularly the growth of leguminous species that are capable of nitrogen fixation. In contrast, application of N in the absence of P has been observed to stimulate the growth of grass species.

Nutrient loading may have possible impact on the emission of methane, a major greenhouse gas, from the soil by affecting the process of methanogenesis. Investigating the effect of nitrogen fertilization on methane uptake revealed that increased soil nitrogen content resulted in lower CH_4 uptake rates. Greater degrees of methane flux from different urea-fertilized irrigated rice fields in India, compared to control, have been reported. The stimulatory effect of ammonium-based fertilizer on CH_4 production is understandable, because methanogens use NH_4^+ as nitrogen source. Keeping in view the deleterious effect of global warming, intense research of applied nature must be in place to counter the possibility of such greenhouse gas emission from the lowland paddies.

Therefore the agricultural development strategy for India in the coming years, particularly for maintaining the biodiversity, must be through increasing productivity of the land under cultivation, with reduced costs of production and higher use- efficiency of inputs with no concomitant harm to the environmental quality. The prime requisite is the promotion of health of the soil–plant–environment system, free from economic exploitation under overuse and abuse of the inputs as if with impunity.

Developing Communities of Inquiry

There is potential to develop communities of inquiry within communities of practice. This goes beyond the development of learning networks which tend to be time-limited projects which focus on information sharing and the replication of best practice. A possible way forward would be the reinvention and the local customization of quality improvement approaches, to increase the absorptive capacity or receptivity within organizations to facilitate the integration and use of evidence in practice. The development of communities of inquiry within communities of practice, is an approach that can be used to foster this customization and local collaborative working for quality improvement in public services.

A community of inquiry could use a variety of action research approaches to break down the division between the production and use of evidence. There is scope for a range of approaches to be used and for adaptation of approaches to suit the circumstances and the type of evidence required. Communities of inquiry may be fostered by providing opportunities for creativity, interaction, dialogue and exchange across professional and organizational boundaries and by valuing the perspective of service users. The sharing of descriptive, first person accounts or 'stories' is an important approach; they provide resonance, connection and insight into the realities of service delivery, particularly where they also involve service users. Sharing stories, narratives or 'critical incidents' through tools such as significant event analysis, action learning sets, appreciative inquiry or whole systems working can open-up inquiry and provide energy for collaboration and change.

Action research can promote collaborative approaches to learning from practice to enhance organizational learning as well as individual learning, when part of a deliberate organizational strategy to value and share knowledge, experience and wisdom of all kinds across whole systems. (http://www.scotland.gov.uk/socialresearch September , 2005).

Epilogue

As pointed out, by Dr. Mangala Rai, Secretary, DARE, Government of India and Director General, ICAR (2006) *the options to harvest the potential benefits are generally resource-intensive, and call for incremental investments in accordance with the size and diversity of the country and critical dependence of our masses on agriculture. Technological advances also demand supporting services, supplies and enabling policies to enable us to become a developed nation. It is, therefore, imperative that these should be aligned for transforming Indian agriculture into a commercial venture with enhanced on and off farm employment, profitability and livelihood security to realize Green Revolution – II in the country.*

Indeed, the applied research, in such changing scenario, has to re-orient itself to keep up the standard in consonance with the ever-changing demand and grass-root realities of the Indian Agriculture.

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WTO (AOA) vis.-a-vis. Indian Exports: Impact and Challenges

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Back Drop

India with diverse soil and climate provides ample opportunity to grow a variety of horticulture crops. These crops form a significant part of total agricultural produce in the country comprising of fruits, vegetables, root and tuber crops, flowers, ornamental plants, medicinal and aromatic plants, spices, condiments, plantation crops and mushrooms. Though these crops hardly occupy 7 per cent of the cropped area they contribute over 18 per cent to the gross agricultural output in the country. Agricultural crops play a unique role in India's economy by improving the income of the rural people. Cultivation of these crops is labour intensive and as such they generate lot of employment opportunities for the rural population. The horticultural crops also ensure the nutritional security to the masses. Fruits and vegetables are not only used for domestic consumption and processing into various products but also substantial quantities are exported in fresh and processed form, bringing much-needed foreign exchange for the country. These crops also provide ample scope for achieving bio-diversity and diversification to maintain ecological balance and to create sustainable agriculture and can make an impact on the national economy in the years to come. With the opening up of WTO regime, the competition of our products is not only with the domestic competitors but also with the global competitors and in this competitive arena, we need to differentiate and promote our products from other global competitors. For the promotion of agriculture produce of, various aggressive promotional strategies need to be deployed to help us accolade our business in the international markets. The Indian contribution to world trade is insignificant even though it is the second largest producer of fruits and vegetables in the world. Even in the field of tropical fruits and vegetables which is its major strength it has not been able to penetrate somewhat satisfactorily anywhere in the global market.

Agriculture Production

- Though agriculture contributes only [20%] of Indian GDP, it sustains approximately more than 1000 million people and determines the growth of national economy.
- India has natural comparative advantage in agriculture with 161 million hectares of arable land (of which 55 MH is irrigated) and widely diverse agro-climatic zones.

Indian Agriculture, therefore, can be easily diversified to meet diverse demands of both domestic and overseas consumers. Indian farm produce has unique aroma, flavour and taste and if marketed properly, would capture the world market.

- India is the third largest producer of food in the world even at the present level of productivity, which is less than half of US level.
- India produces 150 MT of fruits & vegetables (2nd largest), 91 MT of milk (largest), 842 million poultry (5th largest), {417} million livestock (largest), 6.05 MT of fisheries (7th largest). It produces 50% of world's mangoes, 19% of banana, 36% of cashewnut, 11 % of onion, 38%,of cauliflower, 28% of green peas, etc. It has 53% of world's buffalo, 17% of goat and 8000 km of coastline.
- Due to concerted efforts, China over 1990 to 2002 has became largest food producer, from $ 95 b to $ 195b, followed by US from 110b to $ 150$ and India from $ 90 b to $ 105b (WB, 2004).

Global Opportunities and India's Competitive Advantage

The inclusion of agriculture under the purview of World Trade Organization (WTO) has brought forth both challenges as well opportunities for the Indian Agricultural sector. Given the State of play that is likely to exist in the world agricultural trade in the future. We should try to maximize gains and minimize losses The Agreement on Agriculture -(AOA) has many safeguards, relaxations and exemptions for the developing countries, which we must exploit to the advantage of our agricultural sector. It is, therefore, imperative to understand the AOA and its implications, which are analyzed in brief in the following section.

Agreement on Agriculture (AOA)

Salient Features

The agreement provides for the following provisions to promote free and fair trade in agriculture products:

- a framework for long-term reform in the agricultural trade and production policies of the member countries
- establishes rules to discipline one of the most distorted sectors by
- regulating the unrestrained use of production and export subsidies
- reducing import barriers, including non-tariff barriers

- with the objective of developing a fair and market oriented international trading system in agriculture

More specifically, the agreement calls upon members to do the following in the three main pillars of the agreement, that is, market access, domestic support and export competition

Market Access

- Replace all forms of non-tariff barriers such as quantitative restrictions (import quotas, restrictions through permits, import licenses etc.) by tariffs, which are :-
- Reduce bound levels of tariffs progressively
- Open domestic markets for imports, with some exceptions

Domestic Support

- Work out the level of support, that is, Aggregate Measure of Support (AMS), which is provided to the agricultural sector in their respective countries.
- Reduce production distorting support progressively if it exceeds the de minimis levels specified in the agreement, which are 5 percent and 10 percent of the total value of agricultural produce in the case of developed and developing countries respectively.

Export Subsidies

- Reduce value of export subsidies as well as volumes of subsidized exports progressively.
- **Impact on India**

  So far there has not been a significant adverse impact of the provisions of the AOA because the AMS as defined under the agreement is negative. The ceilings on tariffs are fairly high, which provide sufficient room to protect domestic market. There are no reduction commitments on bound tariffs and since exports of agricultural commodities are not directly subsidized, there are no reduction commitments on export subsidies.

WTO Agreement on Agriculture- Perceived Benefits for India

- Estimates indicate that the global trade policy reforms would yield three times the benefit to the developing and the least developed countries than all the Official Development Assistance (ODA) they currently receive (World Bank 2002).

- Reductions in subsidies provided by the developed countries will raise the prices of agricultural products in the world market and this will make our exports more competitive.
- Liberalization of agricultural trade worldwide and further improvements in market access will create new market openings for our products.
- However, we must watch out for
- Weaknesses in the current provisions of the AOA
- Sanitary and phytosanitary (SPS) and Technical Barriers to Trade (TBT)
- Livelihood Security
- Food processing industries have gained importance in recent times both due to the domestic as well as the international market forces.
- The market forces of demand and supply have been in serious engagement with each other since 1995 consequent upon the establishment of the World Trade Organization (WTO).
- The WTO through a series of agreements like Sanitary and Phytosanitary (SPS) and Technical Barriers to Trade (TBT) has impacted production system of the primary agricultural products in addition to the Agreement on Agriculture (AoA).
- The changing consumer knowledge, behaviour as well as reliability of scientific merit on associated risk factors have brought the food safety issues into sharper focus.
- The food processing industries while on the one hand get impacted due to these development, the challenges, on the other hand, are indeed pivotal on the food safety domain that the food processing industries can ill afford to ignore.
- The 'quality competitiveness' on the final product therefore is the major challenge that food technologists' have to address immediately.
- The food processing industries in India are under tremendous pressure to provide safe food. The quality consciousness has become mandatory for all exporting units consequent upon application of various agreement of WTO.

PROBLEMS OF SURPLUS

- Agricultural production is increasing faster than population and increasing marketable surplus of various agri-produce particularly of perishables, has led to unfavourable price regime for the farmers.

- Further, inadequate storage, transport, handling and processing has led to unacceptable level of wastages and value loss, estimated at Rs. [50,000] crores (McKenzie 1997).
- Magnitude of these problems could be well imagined if agri-productivity goes up anywhere near the US level and the plan of diversification of agriculture from non-perishable cereals to perishable like fruits & vegetables, (particularly doubling of horticulture production) is realised.

STATUS OF EXPORTS/ IMPORTS

Reasonable share in global trade is a good indicator of health of the domestic industry. It also ensures continuous upgradation of technology, product and management practices.

- India's share in the global food trade of about $ [450] billion is around (Rs. 33,000 crores) and constitutes mainly of commodity and primary processes items where price realization is low.
- There is wide fluctuation in year to year growth for most of the items which shows exports are largely opportunistic in nature.
- Competitiveness of India export items are coming down, ego India slipped from first to third rank in tea export, it is not competitive even with Vietnam in marine and spices. India is gradually becoming source of the last resort.
- Indian exporters are small scale, undercut each other, export low value-added products to small traders! agents overseas or bulk packaged commodities for processing & re-packaging overseas where real value addition takes place.
- Exports have virtually stagnated over the last 5 years excluding some minor items like mild products and confectionary. In fact, it has declined in major items like tea, spices, coffee and guargum.

CONSTRAINTS IN EXPORTS

- Cost competitiveness, issues in exports
- Quality conforming to international standards,
- Continuous product innovation,
- Brand and market building on global scale,
- Ability to deal in volumes and consistency in supply.

- Domestic support and export subsidies provided in developed countries(estimated at $ 400 billions) and occasional resort to non-tariff barriers have also retarded Indian exports. Non-acceptance of mango on the plea of fruit fly by US, Japan etc is a glaring example of technical barrier to trade.

CONSTRAINTS IN INDIAN FOOD PROCESSING ACTIVITIES

- In the absence of adequate infrastructure, particularly rural road connectivity, inadequacy of information and marketing linkages, and the absence of cold chain systems. Cost of packaging (poor as they are) ranges from 10-54 per cent of production cost. The cold chain capacity caters to less than 10 percent of the produce and within that the facilities are so rudimentary that over 80 per cent are only capable of handling potatoes. High costs and low availability of credit remain a problem because even within the priority sector, lending by banks for agriculture, food processing receives only 4.5 per cent of the unmarketed credit.

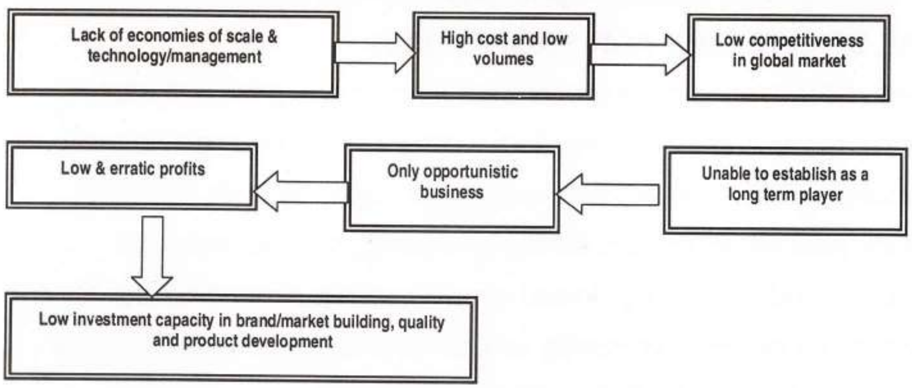

Fig.: Diagrammatic Presentation of Constraints in Export

- The regulatory framework preventing farmers from directly marketing their produce, except through designated agricultural markets, adds to cost and impairs flexibility. A wholesale modification of the Agricultural Produce Marketing Act is an inescapable necessity.
- The ingredients of future policy are constrained in the food Processing Policy, 2005, prepared by the Ministry for Food Processing. These need to be finalized. Issues of infrastructure, adequacy of financing, legal and regulatory framework need to address Synchronization of the aggressive rural roads programme with mobile refrigeration facilities and linking cold chains will minimize waste and improve farm Incomes.
- The most debilitating factor however is the legal framework. Currently, food laws span nine ministries, comprising 13 Central orders alone! In addition, states have their own control orders. Organizations responsible for informing these regulations

are poorly staffed or trained and represent the worst vestiges of the licence permit raj.

STRATEGIES:

The main shortcoming of the present fresh produce market system is the absence of inadequate participation of most producers and retailers in the marketing process. With the significant increase in production of fruit and vegetables coupled with liberalized trade and economic climate, fresh produce will have its own emerging competitive marketing system.

The seasonality of horticultural crops indicates that these are available almost through out the year in one or other part of the country. For promotion of horticulture industry, cool chain facilities, processing units, market infrastructure (with improved backward & forward linkages, contract farming, cooperative bodies, super markets), specialized transportation facilities should be improved. In addition, popularizing regular use of fresh and processed products is highly imperative to tap the non traditional market and minimize post harvest wastage, thereby augmenting income of farmers.

FUTURE STRATEGIES FOR PROMOTION:

- Amend APMC Act to promote contract farming and private markets
- Standardization of picking maturity indices to improve shelf life and quality of fruits
- Promotion of bird protection nets to avoid losses by birds and bats
- Reduce post harvest losses during harvesting, storage, transport
- Establish modern grading, forced air pre-cooling, packing houses for effective PHM
- Establishing modern processing unit for pulp and juice manufacturing
- Develop techniques for bulk preservation of pulp
- The export units should follow codex standards and make them HACCP certified to ensure safety of food products.

VALUE ADDITION: A PROMISING EXPORT ENTERPRISE

Due to the short shelf-life of horticultural crops, as much as 30-35 per cent of fruits and vegetables perish during harvest, storage, grading, transport, packaging and distribution. Only two per cent of horticultural crops are processed into value-added products. Hence, there is a need for maximum commercial utilization of fruits and vegetables. World consumption of **pulp/concentrate** is reportedly increasing steadily in recent years. Concerted efforts should be made to increase export volumes in India.

Exporters of **pulp/ puree** include South Africa, Malaysia, the Philippines, and Thailand & Countries of Latin America (Mexico, Brazil, Peru, and Columbia and Venezuela). The major markets in the EU and the US are the most important destinations for tropical fruit juices, concentrates and pulp/puree. There are also some growing markets in Asia (once the adverse economic/financial developments are overcome) and in Latin America e.g., Brazil.

The fruit industry in India is largely seasonal in nature. Production of various fruit products, largely pulps and concentrates, depend on the seasonal availability of the different fruits. As fruits are available most of the times in year, there is large potential to promote export markets for fresh as well as processed ones.

Export market of fresh fruits could be tapped by increasing its production and productivity and maintaining the quality at par with international standards, while potential of processed fruit, particularly juices and pulp could be harnessed by introducing advanced processing techniques, establishment of advanced processing units in compliance with Codex Standard and proper market research. As HACCP has become mandatory in most developed countries like USA and E.U. and it is required for developing countries like India to meet the mandatory requirements of the major consuming countries.

The Government is rightly realizing the global potential of the processed fruits and vegetables, has classified the horticulture development as a thrust area. The national policies and programmes have been formulated to promote this sector. There are a number of schemes facilitated at Central/State Government levels for development of this industry. Moreover, a number of economic incentives by way of subsidies/grants and soft loans are offered' for various activities leading to the development of this industry. The modem technologies have been developed over the years which have given a big boost to this industry. The major countries producing and exporting the processed fruits and vegetables are Canada and U.S.A for dehydrated peas, potato products, garlic, onion, raisins and prunes; China for dehydrated vegetables, onion and mushrooms, Turkey, Iran and some other countries in the middle east for dried apricot, dates etc.

There is need for the innovative products based on the exclusive and exotic fruit and vegetable products grown in the state. The quality of these products, packaging etc has to conform to the Codex Standards laid under WTO agreement. The production, handling and processing of raw materials have to follow GMP with the incorporation of HACCP systems. The marketing promotion needs to be strengthened and has to be professional in all respects. The production and value addition need to be demand based. The other most significant practices need to be observed in food processing are related to Hazard and Critical Control Point Analysis (HACCP) and Sanitary and Phyto-Sanitary standards (SPS). These are applied for protection of the raw material for food industry from the risks arising from the disease causing organism and other chemical additives, disease carried out from plants, animals and pests. SPS measures are getting universal importance on allowing the import of food products. This industry also needs a Total Quality Management (TQM) system to ensure and maintain quality at every stage of procurement, handling and processing etc.

EXPORT MARKET SELECTION: STRATEGIES AND ASSESSMENT

The export market selection depends on number of factors like size of the national economic system, population, income levels, income distribution, natural resources, rate of economic growth, socio-economic stability patterns, inflationary trends, external debt, exchange rates, banking operations, fiscal and monetary policies, sector analysis, tax structure and system, market structure and competition etc. Before entering into a foreign market, the country needs to analyze the competitive strengths. Then the attractiveness of international markets is compared with the domestic strengths (Box1). A combination of high competitive strengths alongwith high country attractiveness leads to the investment and growth whereas it's opposite results in divestment, mergers and acquisitions.

High	**Invest/grow**		**Dominant /divest joint venture**
Country attractiv-eness		**Selectivity strategies**	
Low			**Harvest/divest combine/license**
	High	**Country attractiveness**	Low

Box 1. Selection of export markets

ROLE OF GOVERNMENT IN PROMOTION OF AGRIBUSINESS

The Government is the central agency which can work in collaboration with other stakeholders for the development of horticulture sector which is going to playa very important role in the state as well as nation's economy. The government has to frame policies conducive for the growth of export and marketing of horticultural products. The public policies are generally framed to help the lower strata by providing them subsidies on fertilizer, pesticides, packing material, arranging trucks for transportation, etc. The state government has taken various measures for the development of horticulture sector. Some of these measures have been discussed below:

The state governments have set up Agri-Export Zones for the purpose of developing and sourcing raw materials and their processing/packaging leading to identify the potential products and the geographical region in which such products are grown and adoption of an end-to-end approach of integration of the entire process, right from the stages of production to consumption. The initiatives taken are to assess the market potential for that produce keeping in view the quality parameters that are required for making this produce/ product acceptable in the international market. Certain interventions are required at each stage of the value chain right from availability of inputs like seeds, fertilizers, pesticides, credit etc. Development of harvesting protocol, IT implementation and post-harvest management are all critical links in the value chain. These would include activities like storage (both intermediate and final), grading, sorting, processing, packaging and transportation. Each of these activities involves a specialized intervention which could be technological or financial. Finally, it is marketing which is the key to the success. The capability to position the product in an appropriate market and getting an appropriate price would ultimately determine whether the AEZ can get going. The 'financial intervention' in the form of various assistance schemes run by a number of Central and State Government organization, enables access to subsidies. Organizations like APEDA, NHB, MOA, DFPI, NCDC and SF AC have provisions for such schemes. Financial assistance gets extended to activities like productivity enhancement, micro irrigation, improvement of quality, R&D, pre-and post-harvest training and extension services, maintenance of cool chain, packaging, apart from market development and freight support for selected products. The 'fiscal interventions' come directly from Central and State Governments with the primary objective of enabling duty-free access to inputs for exports. Thus, advance licenses become available for sourcing duty-free inputs. Facility for concessional duty import of capital goods gets extended not only to direct exporters but also to service providers.

Utilizing the ongoing schemes of various Central and State Government agencies in a coordinated manner, the export zones cover the entire value chain from farm to the consumer. Therefore, their main aim is to look at a agricultural produce in a comprehensive manner right from farm the plate-so as to be able to deliver an appropriately priced and attractively packaged quality product in the international market. This holistic concept will provide remunerative returns to the farmers in a sustained manner and also help in increasing the global competitiveness. Thus, export zones helps in developing state economy, improve economic conditions of all from farmers to trades, generate employment opportunities, improve product quality, reduce cost of the product, assist in development of infrastructure, earn foreign exchange and above all accelerate export growth of the country.

The cost of cultivation of crops is very high and the farmers are not getting desired returns in the market, as they have to depend on the market intermediaries. Thus, the need of giving support to the farmers is necessary. Therefore, government interventions in the system are required at every level. No doubt, the farmers are contributing significantly to the economy, but a rationale has to be drawn - sooner the best. Broadly, the public policies pertaining to horticulture fall into two categories: (a) production, and (b) marketing and consumption with ultimate objective to increase the income to the consumers along with the increase in the nutritional status and satisfaction of the consumers. With regard to production of fruits and vegetables in general, the state government has been providing incentives by the way of technical know-how, supply of plants/seeds fertilizers, plant protection materials, tools and machinery as well as financial assistance. The government is already providing packing material at a very subsidized rate to the farmers, giving back needed facilities for grading, packaging on mechanized lines, purchasing culled fruits for processing purposes and moreover giving competitions to the traders in the terminal markets. To encourage the processing sector, the government has announced minimum support price in case of apples for the first time in the state during the year 2005. The Government has to work in collaboration with other agencies on a **Public-Private-Partnership** model. To boost the agriculture sector, the Government has to invite private sector investment and prioritize the following areas:

- Introduction of advanced technology for the on farm storage of produce and standardization of picking maturity indices so as to improve keeping quality of for better returns.
- Establishing modern grading and packing houses including washing and waxing at farmers/federation levels.
- Construction of fruit and vegetables collection and forwarding centers on road head in the growing area so as to provide shelter from rain and sun.
- Establishing community fruit processing centers at village level for the production of semi-finished fruit products for supply to the bigger fruit processing industries and production of fruit products for consumption in the rural areas. This will help in utilizing about 30 percent of unmarketed fruits, vegetable and also give additional income and employment mostly to the SHGs.

ROAD MAP FOR AGRTICUL TURAL PROSPERITY

Keeping in view the above, it is suggested that following areas should be tapped so that Indian produce may be able to compete nationally and internationally in the value chain.

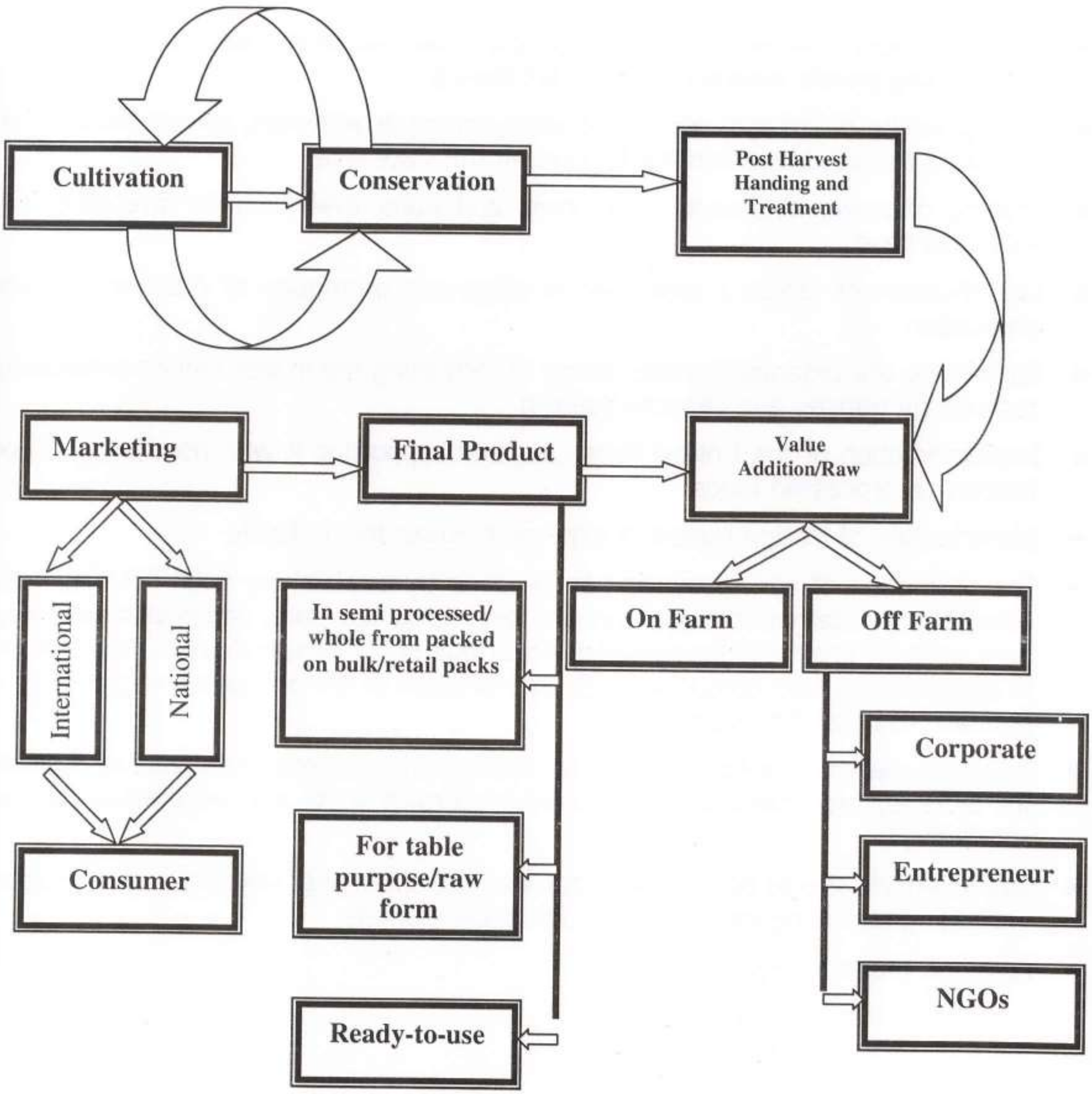

Fig. : A Conceptual Model of Value Chain for the agri-produce

- Existence of vast scope for value-addition by diversification and innovation, public-private partnership, integration of different sectors etc. advance technologies in IT, like GIS
- Strengthening and integration of the domestic marketing system and encouragement to direct marketing.

- An amendment in APMC Act in tune with the Model Act to provide opportunities for establishing private markets and contract faming
- Strengthening of linkages and cooperation among government, private sector and the NGO, the academia and the farmers, at the state level
- Tapping of power abundance, manpower and water availability for strengthening industrial base
- Identification of region / area specific crops and promotion of commercial crop production
- Supporting the organized private sector in increasing the investment on extension, technology transfer and capacity building
- Implementation of the Unified Food Law, and supporting it with nominal total tax burden on processed foods
- Identification of foreign buyers of high-value ethnic Indian foods
- The promotion of agri. products can be done by establishing good linkages with national and international agencies and organizing seminars, participation in trade fairs, organizing exhibitions abroad and distribution of free samples etc. Participation in agri-business fairs abroad will help in promotion of the products and providing a platform to boost the business.
- Small and medium size Agro/Food Parks, which provide common infrastructure facilities for storage, processing and marketing of surplus fruits and vegetables can be established.
- Special efforts should be made to modernize the packaging. New kinds of innovative packaging should be introduced for the global markets.
- Common brand for agri. exports

View of Panalist:

Prof. M.C.Varshneya, Vice-Chancellor, Anand Agricultural University, Anand, Gujarat expressed his views by presenting a paper on

Improvements in the standards of agricultural basic and applied research – general views

Research gives inputs for continuous development. Agricultural development is multidimensional in its objectives and changes with time and hence the research needs to reframe and revitalize its strategies and implementation. Indian Agricultural Research System is applauded for its coordination and efficient management by other countries. At the same time, ever enlarging perspectives and demands of Agricultural development, has constant pressure on promoting further excellence in Indian Agricultural research.

Standard of agricultural research in the case of applied research depends on the contribution it makes in meeting the goals set forth at farmer, regional and national levels, whereas in the case of basic agricultural science, it is the contribution made in understanding various scientific principles in agricultural sciences so that further advancement will be possible.

As of now, applied agricultural research has to be demand driven with following dimensions:

1. Ensuring a decent livelihood for the farmers
2. Enhancing agricultural productivity in view of shrinking of available resources viz. land, water and labour
3. Food and nutrition security for the society
4. Requirements of agro industries which process food and other commercial produce of agriculture
5. Meeting quality requirements of export markets
6. Preserving ecosystems and promoting environmental friendly agriculture

Basic research in the realm of Agricultural sciences should aim at providing innovative ideas and solutions to the above mentioned demand driven applied research. For this purpose it is imperative that it maintains close linkage with the developments in basic sciences. *Post-graduate research should be geared to play an important contribution in basic aspects of agricultural sciences. It is lacking at present.*

Though improvement in the standards cannot be denied by looking into agricultural development and increase in production in different food items and economically important products, one cannot help in concluding slow progress in specific identified objectives and research areas. We will look into some specific areas.

1. *Ensuring a decent livelihood for the farmers*

Research centres in different locations with various levels of constraints have brought out technologies for tribal and shepherds in hilly areas, fishermen and such wide spectrum of people engaged in agriculture. Despite constraints in conducting research in remote areas, success stories have emerged. This is the bright side of the effort.

Integrated farming system should be the demand and objective of todays agriculture. Research with this objective should consider 'farmer first' approach. **Farmer Participated Research**, though vaguely followed, can be effective in understanding and solving the problem of the farmers. It need not be direct participation but can be indirect i.e., survey and other means. Profitability is not linked to only reduction in cost of cultivation but also in value addition and marketing strategies which can come out only in such participatory approach.

2. *Enhancing agricultural productivity in view of declining land area for agriculture*

India has come long way in increasing agricultural production in different agro climatic conditions across the country. Truly, the research conducted in various research organizations have made this to happen. However, loss of productivity in certain irrigated areas, continued low productivity in dry lands and other problematic soils etc. show that we have research management problems in addressing these issues. *Multidisciplinary approach, though on paper, has not taken shape to give required impact.*

Self sufficiency in food grains can no longer give any complacency.

Urbanization and industrialization take away fertile lands and enhancing productivity in general and particularly in lands with various constraints becomes important. Emphasis on location specific cropping systems and farming systems that can promote overall productivity of land with higher remuneration is the need of the hour. *Farming systems* offers a remunerative technology but within the skills of the farmers. Despite its scope and relevance, it has not received much attention probably due to its complexity. Future requirements demand working on such complex systems and bringing better livelihood to farmers. *Addressing simple issues and publishing them alone cannot improve the real* *focus needed. Project impact evaluation remarks rather than number of publications should serve as criteria in such cases.*

3. Food and nutrition security for the society

The economics that is calculated is limited to yield and quality consideration is seldom reflected unless specific higher rates are obtained in the market. In many crops, farmers get same price even if quality in terms of nutrients or pollutants differs. Till such time market recognition is obtained, the quality advantages should be added as additional advantage and propagated. We need to develop a *multidimensional index in evaluating various technologies* so that research objectives are fully addressed.

4. Requirements of agro industries which process food and other commercial produce of agriculture

Though good work has been done in specific areas, its linkage with production technologies is not that high. Some industries go for contract farming to ensure their requirement. It is an area to be addressed in public funded research institutions by developing closer ties with industries. In crop based research, real integration of quality in terms of nutrition and processing is yet to take place. *Because of globalization, industry can get their raw material from anywhere and hence our produce need to be cost effective in comparison and also acceptable in quality.*

5. Meeting quality requirements of export markets

This is an emerging area that needs immediate attention. We need sophistication in research, training in special techniques and close liaison with industries.

6. Preserving ecosystems and promoting environmental friendly agriculture

It is a real challenge. While organic farming may be ideal, in many a case it is not cost effective. Research on modern crop improvement techniques and efforts in making different components of organic farming viable, can change the situation.

7. Newer areas

Nanotechnology

New agro technological innovation can add resilience to agriculture and can very well help to keep the threats of famines at a distance. Now, era of Nanotechnology has begun – It is technology related to engineering of functional systems at a molecular scale.

It offers better built, longer lasting, cleaner, safer and smarter products for agriculture and agriculture based industry.

Some of the examples are Recombinant DNA, GMO (Genetically Modified Organism), Use of Probiotic - Prebiotic, Genetic engineering etc.

Organic Farming – A holistic food production

Among all farming systems, organic farming is gaining wide attention among farmers, entrepreneurs, policy makers and agricultural scientists for varied reasons:

- it minimizes the dependence on chemical inputs (fertilizers, pesticides, insecticides etc.)
- improves quality of produce and environment
- provides opportunity to rural employment
- improves human health
- Low cost with sustainability

Crop modeling

Crop growth simulation models play a vital role in bringing out the specific relationship between weather conditions and plant productivity and provide capabilities for transferring agricultural production technology from sites of origin to new location. Crop growth simulation models not only help in understanding climate crop interaction but also in evaluating the potentials of various soil and crop management alternatives and thus can form an important component in system approach research.

Crop growth simulation models have been recognised in environmental characterisation and agro-ecological zoning defining research priority, technology transfer, estimate production potential, strategic and tactical decision-making and for predicting the effects of climate change and variability. In order to sustain the higher production and to minimize the environmental degradation, understanding of crop growth in relation to varying resource inputs and agro-environments for management options is required. Crop models are recent tools that can facilitate identification of production constraints and assist in agro-technology transfer and improvement. They are being widely used as management tools to evaluate the effects of climate, soil, hydrologic and agronomic factors on crop yield and its variability. Crop simulation models have been used to determine potential yield of any crop in which, the yield gap in a given environmental situation can be determined and possibilities for the yield improvement can be assessed.

Climatic change and its effect on Agriculture

The IPCC Fourth Assessment Report released in February 2007 has confirmed that warming of climate system is unequivocal, as is evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level. At continental, regional, and ocean basin scales, numerous long-term changes in climate have been observed. These include changes in Arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones. The report has pointed out with high level of confidence that the warming is due to human activities. Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities.

It seems obvious that any significant change in climate on a global scale should impact local agriculture. Considerable study has gone into questions of just how farming might be affected in different regions, and by how much; and whether the net result may be harmful or beneficial, and to whom.

Scientists predict that because of global warming, this already fickle weather system could become even more undependable. Semi-arid regions of western India are expected to receive higher than normal rainfall as temperatures soar, while central India will experience a decrease of between 10 and 20 per cent in winter rainfall by the 2050s. Agriculture will be worst affected in the coastal regions of Gujarat and Maharashtra, where agriculturally fertile areas are vulnerable to inundation and salinisation. Standing crop in these regions is also more likely to be damaged due to cyclonic activity. In Rajasthan, a 2°C rise in temperature was estimated to reduce production of pearl millet by 10-15 per cent.

Other aspects:

1. There needs to be *continuity in developing research strategies* in national level projects like NARP, NATP and NAIP. The concepts of NARP have remained, for most parts, in Status report. We need a rethinking on this aspect.
2. Location specific research has certainly contributed in replicating successful technologies across the country. It has to be continued. But *innovation is the key to successful* research and the thrust for it is equally important. Solutions for problem solving and spread of such solutions should not be confused with one another and each has its own role but the former requires greater attention.

3. We have conferences in identifying broad research areas and workshops and annual meetings in framing experiments. Yet *there is scope in framing of individual experiments* in keeping with specific objectives which are yet to be achieved.
4. Due to *want of experienced scientific man power*, research and teaching suffers. In many public funded institutions, sanctioned posts are not permitted to be filled. It is high time to take remedial measures.
5. Standard of educational institutions requires a thorough review and evaluation. Unlike in the past, the emerging issues are not adequately addressed in the present agricultural research and educational system.
6. Research endeavour needs sustained funding. Even though 65 to 70 % of Indian population is engaged in Agriculture the allocation of grants for Agricultural Research and Education is hardly 0.04 %.
7. If Research is to play its proper role in society, then research scholar should maintain the ethical behavior.
8. The Research objectives should have congruence with national legislation, regulation and dignity.
9. Research workers should either principles and practices of valid experimentation such as scientific method, accurate and sufficient sampling, accurate record keeping and reporting.
10. Training of scientist in the latest research area with the latest technology should be a routine feature.

Dr. S.S. Kadam, Vice Chancellor, Marathwada Agricultural University, Parbhani (MS) emphrised the following points for

IMPROVEMENT IN STANDARDS OF BASIC AND APPLIED RESEARCH

- There has often been a debate on research being conducted in the universities.
- Research in basically of two types – basic (fundamental) research undertaken in free state of enquiry to acquire knowledge. Applied (developmental) research undertaken to acquire knowledge or resource that has practical application to problems of society.
- Basic research is pursued in practically all disciplines and especially so in the departments belonging to the faculties of arts, humanities and natural sciences. It contributes to the intellectual development of faculty and students. In basic research, the initiative is generally taken by individuals or research groups, not by the institution. The nature of research undertaken and its quality is based on tradition, ability of the faculty and available facilities.
- Applied research is undertaken largely in the laboratory based science and technology department, some social science departments and the professional academic institutions. The type of research reflects the needs of society. While funding for basic research generally comes from the university and government agencies, applied research may also receive money from industry, business and houses.
- Research in science, technology, medicine and agriculture requires substantial financial support which government and other public agencies provide. Hence universities are looking to industry for support through contract research. The industry sponsored research is usually for specific purposes oriented towards production or improvement in quality of product(s) and therefore in many cases confidential. This is contrary to the traditions of universities and of academics who believe in publishing the results are early as possible.
- Issues in research – identification of priority areas linked to the needs of society and stakeholders, strong linkages, HRD for technology up-gradation, funding, competent teachers, appointment of examiners, research managers of high academic profile, capacity building, professional seriousness, concurrent evaluation, adequate preparation, stringent eligibility criteria, conducting research in isolation or piecemeal, inadequate infrastructure and scientific manpower, defective research methodologies, short listing of post graduate and university research programmes, leaving half way post graduate research, plagiarism, quality assurance, mutual obligations of examiners,

low key research, assessing research impacts in the form of success stories, adoption, etc.

- Challenges on research front include lack of funding, lack of enthusiasm, large scale migration, fast changing scientific knowledge, harnessing linkage and accreditation.
- For improving research remedial measures like restricting, number of research scholars, establishment of research cell for funding, competent referees, examiners or experts, rigorous colloquia, creating data base on doctoral research and research technologies at national level, keeping reports of examiner and approved theses in library, knowledge of study area, familiarity with research literature, technical skill in laboratory work; oral, written and visual communication skills, skill in designing experimental protocols, pre-Ph.D. courses, critical evaluation of theses, publication of research in reputed journals, accreditation of post graduate programmes, creation of separate institutes for research, continuous evaluation of research programmers and planning research commensurate with national policies to achieve targets.

Repportears:

- Dr. A.K. Singh,
- Dr. Chattopadhyay,
- Dr. Atul Kumar

Honouring Dr. Mangala Rai, Secretary, DARE and DG, ICAR

Plenary Session of 32nd IAUA Vice Chancellor's Annual Convention

TECHNICAL SESSION-IX

Presentations of the recommendations

Chairman: **Dr. M.P. Yadav,** President, IAUA & Vice Chancellor, Sardar Ballabh Bhai Patel University of Agriculture and Technology, Modipuram

Co-Chairman: **Dr. N.N. Singh,** Vice Chancellor, BAU, Ranchi

RECOMMENDATIONS OF 32nd IAUA VCs CONVENTION HELD OF BIRSA AGRICULTURAL UNIVERSITY, RANCHI DURING DECEMBER 20-21, 2007

Session-I: Diversification in Indian Agriculture vis-à-vis resource utilization.

Chairman: Dr. Gautam Kalloo

Co-Chairman: Dr. K.R. Kaundal

Recommendations:

- Massive education programme backed by infrastructure and policy support is needed to change mind set of farmers to produce more.
- Series of network of projects are required for hi-tech agriculture.
- Micro level approach is required to increase production and productivity.
- Areas like food distribution system, agro-processing, health facilities and market reforms needs to be strengthened to bring diversification in Indian Agriculture.
- Rural communities should be made stakeholders in formulating policies related with diversification.
- Training of scientists is needed for diversification management.
- Public private partnership is a must for diversification.
- Marketing and value-addition is must for perishable commodities because farmers are getting distressed sale.

Session-II: Sustainable utilization of plant, animal, microbial and natural resource diversity for agricultural production and augmenting income and employment.

Chairman: Dr. M.P. Yadav

Co-Chairman: Dr. Dilip Kumar

Recommendations:

- Strengthening of lab to land programme is required.
- Region-wise selection of suitable microbes for diversification is required.
- Holistic but localized approach is needed for agricultural development.
- Organic research areas should be fixed year after year, it should not change. Soil profile, microbes etc. should be studied.

Session-III: Role of organic farming for diversification in Indian Agriculture.

Chairman: Dr. D.P. Ray

Co-Chairman: Dr. V.K. Suri

Recommendations:

- There is need for a nationwide programme for production of quality inputs, processing and the certification of organic produce. Region specific strategy should be formulated for production of organic inputs overcoming the constraints of certification procedure and the costs of organic produce.
- A task force on organic farming should be formed.
- Organic farming should be promoted in the specific areas in collaboration with NGO/SHGs wherever possible.
- Massive awareness programme about organic farming should be taken up through training and demonstration. Financial and institutional support is required to be enhanced to popularize organic agriculture.

- State Agricultural Universities need to be recognized as certification agency for organic farming.
- Referral Laboratories are required to be established at district level.
- Appropriate measures for marketing of organic products needs to be followed. Buyback system for the organic produce should be introduced so that farmers would fetch better and assured price.

Session-IV: Farming system approaches for livelihood security through cropping livestock and other alternatives i.e. mushroom, honey, resin, gums, fisheries etc.

Chairman: Dr. B.K. Bikani

Co-Chairman: Dr. S.K. Mann

Recommendations:

- Apiculture should be made an important IFS component in India with the impetus on Floriculture, Horticulture and Vegetables cultivations.
- Mushroom cultivation and crop residue cycling is one of the best way to add nutrient & economic value to the cereal based cropping systems.
- Fish and goat in the irrigated cropping system, deep water rice + azolla and fish and in rainfed condition farm pond + birds + diary and agro-forestry are economically viable farming system.

Session-V: Export oriented agricultural production with context to WTO, GATT opportunities strategies and action plan.

Chairman: Dr. Sushil Kumar

Co-Chairman: Dr. Basant Ram

Recommendations:

- Public Private Partnership should be promoted to support domestic as well global trade.
- Concept of value chain and its management should find a prime place to provide sharp edge to domestic and global trade.
- Emphasis on reduced cost of production and quality assurance as per the global trade to be ensured.
- Preparedness is required for requisite infrastructure, skill development and other provisions for trade promotion.
- Marketing intelligence mechanisms should be strengthened.
- India alongwith other developing countries must continue to work for seeking freer trade in terms of whole range of subsidies and greater transparency in the application of SPS rules and regulations.
- There is a need to simplify export procedures.

Session-VI: Impact of globally oriented civilization on Indian agriculture.

Chairman: Dr. J.H. Kulkarni

Co-Chairman: Dr. R.K. Samanta

Recommendations:

- Specialization and contract farming needs to be popularized with market assurance for products.
- More number of items should be brought under green box.

- One nodal authority should be made for export problems.
- Farm mechanization area needs to be strengthened.
- Subsidization should be increased keeping global trade in mind.

Session-VII: Bio-component models for integrated farming system.

Chairman: Dr. S.S. Baghel

Co-Chairman: Dr. N.L. Maurya

Recommendations:

- Models needs to be modified as per availability of land to farmers in IFS.
- Eco-village concept should be popularized.
- Location specific and need based model should be developed for IFS.

Session-VIII: Improvement in the standard of research (with Basic & Applied).

Chairman: Prof. M.C. Varshney

Co-Chairman: Dr. K.R. Koundal

Recommendations:

- Reorientations of plant breeders in the recent approaches of plant breeding such as molecular markers, marker aided selection for crop improvement is required.
- We need to recruit competent and intelligent faculty for teaching and research in various SAUs.
- There is need to train faculty in the frontier areas of research in the advanced laboratories within India and abroad. Need based trainings are important for doing good quality research at various institutions.
- Research projects need to be pursued in a networking with different institutions & laboratories having expertise and competence in the proposed research projects in a mission mode to achieve the set objectives.

- For applied research newer areas such as crop modeling, nano-technology, climate change and its effect on agriculture etc. should be given priority.
- For improving quality of research to increase agricultural production with reference to global competitiveness, the quality of human resource engaged in research should be improved by imparting trainings at national and international levels.
- Convergence of basic science and technological interventions for precision farming in agriculture is the need of the day.

Repporteears:

- Dr. A.K. Singh,
- Dr. Chattopadhyay,
- Dr. Atul Kumar

PLENARY SESSION

Chairman: Dr. Mangla Rai, DG, ICAR

Dr. Mangal Rai was very much satisfied with the theme of the Vice Chancellor, Convention and said that it is the need of the hour to think in the area of diversification in Indian Agriculture. He minutely discussed about the topics that were chosen for discussion in various technical session. He was of the opinion that the time frame given for discussions of these topics are not enough and they need to be discussed in great detail to come out with real output, out of it. He said that there is a need to identify newer intervention for diversification depending on its resources on country basis. The present situation should be thoroughly assessed and sustainable models should be framed in accordance with it. The future projection which is made only on the basis of weather parameters should also consider various diversification modules operating in the country and then only real future projections can be made. He asked all the VCs to build strong linkages amongst them shelves so that any refined technology over old modules which is of immense help to the farmers will reach to each and every part of the country in short period of time. This will improve the standard of living of many farmers of the country for which the scientists are working. In turn the production and productivity will increase and the country will have surplus to feed its burgeoning population. Chairman emphasized that the current agricultural production scenario reflects some disturbing tendencies from the point of view of human nutrition, particularly in rural areas where production and consumption are directly linked, and for the poor everywhere. Decline in areas of coarse cereals and pulses and other so-called 'low-value' crops which provide access to better nutrition for the poor, illustrates this concern. On the other hand, substitution of these crops by those with higher productivity has improved calorie availability and incomes of farmers who can increasingly afford better nutrition. Over the last 10-15 years, there has been a remarkable spurt in production of horticultural crops, livestock and fisheries, driven largely by buoyant domestic demand. Average per capita consumption of these commodities has increased.

Cropping patterns have traditionally been dominated by food needs. Commercial crops were confined to some regions and on relatively larger farms. The system we inherited at the time of independence became unsustainable as rapid population growth outstripped our capacity to produce food. Fruits, vegetables, milk, meat, fish, became luxury foods, whose demand was confined to the very small rich class in rural and urban areas. A food insecure nation, despite devoting bulk of its agricultural resources to food production, became chronic importer of food. Even extension of cultivation to marginal and sub-marginal lands did not help.

The Green Revolution transformed this scene. In less than a decade we were able to achieve reasonable food security. High growth in productivity of cereals spurred agricultural growth and incomes. Rising incomes prompted shifts in consumption patterns and demand for non-cereal food became buoyant. By mid-eighties expansion of area under cereals ceased. Producers too began to look for alternatives and the process of diversification set in. It became the *mantra* for agricultural development in the nineties.

Driven by self-sufficiency motive, cropping patterns in India were locked to foodgrain production for a long time—a few regions devoting some resources for commercial crops like cotton, sugarcane groundnut, etc. or plantation crops. As foodgrain production saturated markets, a trend towards diversification set in. Changes in pattern of domestic demand and, to some extent, export demand in the wake of trade liberalisation, resulted in changes in resource use and increasing diversification of enterprises. States which diversified the crop sector in a big way, have attained relatively higher growth in the net state domestic product of agricultural sector during the past two decades.

The factors that led to diversification of agriculture have varied, over time. During the first 15 years following the onset of Green Revolution, irrigation played the most important role, predominance of small holdings discouraged it. Abundant and cheap supply of electricity also fostered specialisation. Since early eighties, credit availability emerged as a significant determinant of diversification. Smaller farms continued to face rigidity in cropping patterns because of binding food production constraint. They diverted their attention to livestock enterprises. At the end of the millennium, there was consensus that diversification to higher value enterprises like, vegetables, fruits, other specialty crops, livestock products, fisheries, value-added agricultural products etc., was the new pathway for income growth in agricultural and rural sector. This would also help in bridging the quality gaps in terms of nutrition.

Lunch at Damodar International Guest House, BAU

Lunch at Damodar International Guest House, BAU

The following members participated in the 32nd IAUA Vice Chancellor's Annual Convention on Diversification in Indian Agriculture held at Birsa Agricultural University, Ranchi during December, 20-21st, 2007

Sl. No.	Name	Designation with address
1	Dr. Mangala Rai	Secretary, DARE and D.G., ICAR Indian Council of Agricultural Research,Ministry of Agriculture, Krishi Bhavan, New Delhi-110001
2	Dr. S.S. Baghel	Vice ChancellorAssam Agricultural University, Jorhat-785013 (Assam)
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7	Dr. Sushil Kumar	Director NDRI, Karnal
8	Dr. N.N. Singh	Vice ChancellorBirsa Agricultural University, Kanke, Ranchi
9	Dr. Dilip Kumar	Director, CIFE, Mumbai
10	Dr. C.S. Chakrabarty	Vice ChancellorWest Bengal University of Animal & Fisheries, Kolkata
11	Dr. J.H. Kulkarni	Vice ChancellorUnivresity of Agriculture Sciences,Dharwad
12	Dr. V.K. Suri	Vice ChancellorChandra Shekar Azad University of Agriculture & Technology, Kanpur-208002 (UP)
13	Prof. D.P. Ray	Vice ChancellorOrissa University of Agriculture & Technology,Bhubaneshwar-751003(Orissa)
14	Dr. P.G. Chengappa	Vice ChancellorUniversity of Agriculture Science,Bangalore

15	**Dr. A.S. Nainawe**	Vice ChancellorMAFSU, Nagpur
16	**Dr. Basant Ram**	Vice ChancellorNDUA&T,Faizabad
17	**Dr. Gautam Kaloo**	Vice ChancellorJawaharlal Nehru Krishi Vishwavidyalaya,Jabalpur
18	**Dr. N.L. Maurya**	Vice ChancellorRAU, Bihar, Pusa (Samastipur)PIN: 848125
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20	**Dr. S.N. Pandey**	Ex. Vice Chancellor & OSDBirsa Agricultural University, Kanke, Ranchi
21	**Dr. R.P. Singh**	Executive Secretary, Pusa Campus, IAUA, New Delhi
22	**Dr. Bangali Baboo**	DirectorIndian Institute of Natural Resins and Gums, Namkum, Ranchi
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30	**Dr. O.P. Sharma**	Dean, Agriculture CSK, Himachal Pradesh Agricutlure University, Palampur

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37	**Dr. N.K. Rai**	DSWBirsa Agricultural University, Kanke, Ranchi
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and Chancellor of Universities of Jharkhand