



Kurukshetra

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Increasing Agricultural Productivity





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Malnutrition Quit India

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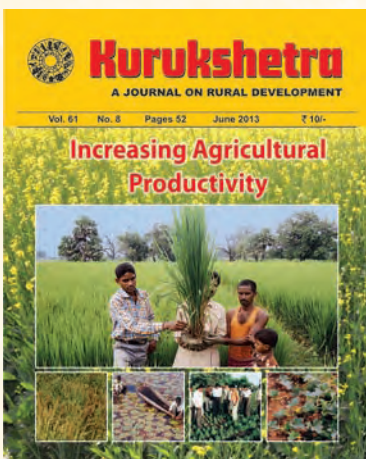
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Kurukshetra seeks to carry the message of Rural Development to all people. It serves as a forum for free, frank and serious discussion on the problems of Rural Development with special focus on Rural Uplift.

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INSIDE

Agriculture is the mainstay of India which provides employment to nearly 52 per cent of the population. However, Agriculture contributes only 16 per cent to India's Gross Domestic Product. Increasing agricultural growth is the top priority of our government and will continue to remain, as around 70 per cent of the population lives in rural India.


Agriculture plays an important role in economic development, such as provision of food to the nation, enlarging exports, transfer of manpower to non-agricultural sectors, contribution to capital formation, and securing markets for industrialization.

India is the world's largest producer of milk, pulses and spices and has the largest area under wheat, rice and cotton. The effectiveness of Indian agriculture is the effectiveness of the Indian economy. In the geographical aspect India has the highest advantage of farm area under cultivation, but the yield is neither encouraging nor remunerative to the cultivators. In China net cropped area is only ten percent while the world average is 10.7 percent.

There is a limit to cultivable land, which is currently 11 per cent of the 13.2 billion hectares of the total land area of the planet, the rest being taken up by forests, settlements and grass lands etc. So the solution lies in increasing productivity of agriculture.

In spite of the Green Revolution, our agricultural productivity continues to be low at 1.7 tons per hectare as against the world's average of 2.6 tons/ha.

In India, Green Revolution in agriculture has made significant contribution on aggregate supply of food grains, ensuring food security to the growing population. However, the momentum gained during the period of Green Revolution has slowly declined. Now, the agricultural growth faces a serious challenge in terms of sustainability. Today, the main problem in agriculture pertains to sustainability of resources, use and indiscriminate use of chemical fertilizers and pesticides. These problems have led to increasing awareness and a felt need for moving away from the input intensive agriculture perused during the Green revolution phase, to sustainable farming in different parts of the world. Better agriculture practices are needed to bring sustainability in Indian Agriculture.

In this issue we focus on issues relating to agricultural productivity which will affect the growth in the agriculture sector and finally the quality of life of the people, majority of which lives in the rural areas. 

TECHNOLOGY INNOVATIONS TO INCREASE PRODUCTIVITY IN AGRICULTURE

Dr. Harender Raj Gautam and Er. Rohitashw Kumar

Agriculture has to match the pace of the population growth to counter hunger and poverty in the world particularly in the developing countries. Cereals are the dominant part of our food security and world cereal output in 2012 was 2.309 billion tones. It is estimated that the world population will be 9.1 billion persons by 2050, up from the current population of 7 billion. More importantly, income growth will increase the quantity and change the composition of agricultural commodity demand. Demand for energy will also compete with the food security as parts of our agricultural commodities are going for the production of bio-fuels which will also continue to grow. Thus, significant increases in production of all major crops, livestock and fisheries will be required. According to the estimates of the Food and Agricultural Organization (FAO), agricultural

production would need to grow globally by 70 per cent by 2050 and more specifically by almost 100 per cent in developing countries, to feed the growing population alone. This excludes additional demand for crops as feedstock and the demand for bio-fuel sector.

Today, agriculture is in serious constraint due to the challenge of hunger, malnutrition, poverty and climate change. Some recent estimates suggest that total factor productivity (TFP), the most comprehensive measure of productivity reflecting the efficiency to turn all inputs into outputs, grew at an average rate of around 2 per cent per year since 2000 across major world regions. The most popular indicator of land productivity is crop yield. This is a worrying factor as the average global rates of growth in yield of most of the major cereals are



declining. Since the 1980s, growth in wheat and rice yields fell from 2.5-3 to around 1 per cent. Maize yields showed growth of slightly less than 2 per cent over the last decade. This is the major concern due to the lack of technology transfer. The gap between farmers' yields and technical potential yields reflects the largely suboptimal use of inputs and insufficient adoption of most productive technology. According to FAO, this yield gap was approximately 11 per cent in East Asia and with unequal access to resources and inputs could raise total agricultural output in developing countries by 2.5-4 per cent which can lead to a reduction of 12-17 per cent in the number of undernourished globally.

Indian Scenario

Sustainable agriculture growth is important to check the hunger and poverty in the vulnerable population of the country as for 1 per cent growth in agriculture sector there would be a 2-3 per cent reduction in poverty. India's population is expected to reach 1.5 billion by 2025, making food security most important social issue and food production will have to be increased considerably, to meet needs of growing population. The farm sector achieved 3.6 per cent growth during the 11th Five Year Plan (2007-12) which was much higher than growth of 2.5 and 2.4 per cent during 9th and 10th Plans. Food grains production in India has shown remarkable improvement in recent years. The production of food grains in 2011-12 was at a record high of 259.32 million tones.

While focusing on increasing productivity in agriculture, innovative technologies should be infused to lower production costs, conserve biodiversity, more efficient use of external inputs for more sustainable agriculture and environment, increase stability of production to lessen suffering during droughts due to abiotic and biotic stresses. Indian agriculture has all capabilities in the form

of technology and management to accelerate the growth.

The Planning Commission has targeted an annual growth rate of 4 per cent for the agriculture sector in the Twelfth Five-year Plan. This is evident from the statistics as the production of food grains has increased by 4 times, horticultural crops by 6 times, fish by 9 times (marine 5 times and inland 17 times), milk 6 times and eggs 27 times since 1950-51. Green Revolution is our biggest success which resulted in an increase in food production from 800 million tonnes to more than 2.2 billion tonnes between 1961 and 2000. Indian Council of Agricultural Research (ICAR) with 99 institutes, 65 Agricultural Universities and 631 *Krishi Vigyan Kendras* (KVKs) spread across the country constitutes one of the largest national agricultural

research systems in the world. But now, there is need for another green revolution by tapping the unexplored potential of vast tract of the country with the augmentation of irrigation and technology.

Our agriculture is still technology deficit as far as world agriculture is concerned. Yields

per hectare of foodgrains, fruits and vegetables in our country are far below global averages. Our rice yields are one-third of China's, and about half of Vietnam's and Indonesia's. Even India's most productive states lag global averages. For example, Punjab's yield of rice in 2010 was 3.8 tonnes per hectare against the global average of 4.3 tonnes. The average yield for apples in India (J&K) is about 11 tonnes per acre compared to the US, New Zealand, Israel or China, where yields range 30-70 tonnes per acre. The available data show that the productivity of kharif sorghum can be increased 3 to 4 times, rabi sorghum 1.4 to 2.3 times and bajra 1.8 to 2.3 times from their current level of productivity. Similarly, the productivity of pulses and oilseeds can be increased 2.3 to 2.5 times, through attention to seeds, soil health, pest management, crop life saving irrigation and post-harvest technology. Supplemental irrigation based

The most popular indicator of land productivity is crop yield. This is a worrying factor as the average global rates of growth in yield of most of the major cereals are declining.

on rain water harvesting will help to increase yields further. A second area needing immediate attention and action relates to improving the productivity of wheat, rice, pulses and oilseeds in the Indo-Gangetic plains and eastern India, particularly in Bihar, Jharkhand, Chhattisgarh, Orissa, eastern Uttar Pradesh, West Bengal and Assam. According to a report of Chambers of Indian Industries (CII) and McKinsey, the country's agricultural output by 2030 could reach Rs 29.28 lakh crore level and food exports could jump to over Rs 7 lakh crore. Consequently, processing could grow from Rs 1.1 lakh crore to Rs 5.65 lakh crore by 2030 while India's food exports could grow from Rs 1.4 lakh crore to Rs 7.72 lakh crore by 2030. The new Food and Agriculture Integrated Development Action (FAIDA) report focuses on mango, banana, potato, soyabean and poultry which represent categories that are likely to drive the next wave of growth.

Agriculture is the largest water user worldwide, representing about 70 per cent of total withdrawal. Agriculture is also a major source of water pollution from nutrients, pesticides, soils and other contaminants, leading to significant social, economic and environmental costs.

Need for climate change resilient technology

Climate change is the biggest threat to sustainable agriculture in the world. Global agriculture will need to adapt to climate change. There is growing evidence that climate change has had negative effects on agriculture and particularly in developing countries. Agriculture (including deforestation) accounts for about one-third of greenhouse gas emissions; for this reason, it contributes significantly to climate change mitigation. Agriculture is the largest water user worldwide, representing about 70 per cent of total withdrawal. Agriculture is also a major source of water pollution from nutrients, pesticides, soils and other contaminants, leading to significant social, economic and environmental costs. It also damages the wider environment through the emission of greenhouse gasses. In some intensive farming systems, up to 50 per cent of available inorganic

and organic nutrient inputs are not always utilized by crops or pastures, leading to significant pollution from nutrient run-off. The scenario is just opposite in the case of large parts of the developing world, where crop farming leads to a net extraction of nutrients from the soil.

While crops can be adapted to changing environments, the need to reduce emissions will increasingly challenge conventional, resource-intensive agricultural systems. Productivity growth needs to increase to keep up with demand growth,

but also to increase resilience of the sector to supply shocks, whether due to climate change or due to resource limits more generally. Agriculture planning in future has to take into consideration the total scenarios of land, water and energy keeping in view the demand of food and other agricultural commodities. Indian Council of Agricultural Research has taken various initiatives to mitigate the impact of climate change such as National

Initiative on Climate Resilient Agriculture (NICRA) and development of abiotic stress tolerant crops. During 2011-12, more than 15000 germplasm of wheat and 2000 germplasm lines of other crops like rice, maize, pulses were screened for drought, heat and submergence tolerance which are the major climatic stresses and more than 50 promising lines were identified in different crops which will be used for breeding purposes during next year. Drought and flood coping technologies were demonstrated on farmers' fields for adoption in large number of villages for up-scaling. For agriculture to respond to future challenges, innovation will not only need to improve the efficiency with which inputs are turned into outputs, but also conserve scarce natural resources and reduce waste.

Better management of water resources

Availability of water is most critical for increasing the productivity in agriculture. In India, around 78

per cent water goes to the agriculture sector, while the remaining part shared out between drinking, industry and other usage. Therefore, it is required that water storage facilities to be increased in the country to 450 million cubic meter by 2050. Dry land agriculture should be the main focus area as more than 60 per cent of the cultivated area in the country is without irrigation. The Centre had earmarked 60 per cent of allocation to agriculture in dry land farming in the 12th Five Year Plan to provide major thrust to enhance agriculture production.

Need to infuse innovative technologies

Technology transfer in agriculture should focus on key interventions at different stages of the crop from sowing of the seed, crop protection, harvesting, post-harvest management and marketing. There is need to infuse innovation systems in agriculture that allow more sustainable use of resources, such as no-till farming, insect-resistant crops, more efficient irrigation, water management systems, sensors for nutrient status in crops, remote sensing and Geographic Information Systems (GIS) to improve and monitor land use and SMS messaging for enhancing advisory services to farmers. ICAR has taken number of steps for technology dissemination and human resource up gradation. Presently, more than 300 KVKs are providing Kisan Mobile Advisories to farmers on their registered mobile phones. In the year 2011-12, about 1.10 lakh short text messages (SMSs) were delivered to 13.40 lakh farmers for timely actions. Student ready scheme is one such thrust area for 12th Five Year Plan. Village Knowledge Centres, and online databases in local languages should be established. Fast technology dissemination will certainly reduce the knowledge deficit with the farmers and will help in accelerating the stagnant growth of agriculture, realizing higher potential of our land and hard work of our farmers. Under this, students of around 11 branches of agriculture will be given training in skills, knowledge, attitude, innovation and confidence. The thrust of this

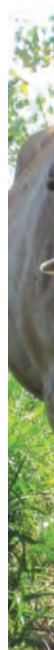
scheme is to give hands on experience on working in rural areas and ICAR has come up with more than 300 experiential learning models for agri-graduates. Our traditional knowledge is also one of our important time tested technologic asset. Agricultural universities across India will now be able to take on board progressive farmers as teaching faculty in their respective institutions. It is known that a traditional Indian farmer has nearly 40-50 skill sets with him and that is why they can be equally good teachers on par with teaching faculty in agricultural varsities.

Potential of biotechnology

Biotechnology is one of the important area which with the help of various technologies like Genetically Modified crops can lead our agriculture to a higher trajectory of growth. GM food crops along with other GM non-food crops were grown by farmers in 160 million hectares, in 2011 in more than 25 countries wherein the share of the developing countries is 46 per cent. India grows transgenic Bt. Cotton in 8.4 million hectares. The government has approved 17 GM crops of 8 traits which are of virus- and bacteria-resistant as in 2012. The country has also developed golden rice which is rich in β -carotene. This is a great solution for India as nearly 5,000 children go blind every year because of β -carotene deficiency. According to the information from the National Research Centre on Plant Biotechnology, two golden rice varieties with vitamin-A -- *Swarna* and *Jaya* would be tested in open fields in 2013 and the Bt pigeon pea and chickpea would be released for field trials in 3-4 years.

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Dryland agriculture should be the main focus area as more than 60 per cent of the cultivated area in the country is without irrigation.



AGRICULTURE AND RURAL INDIA'S MILLENNIUM COMMITMENTS

Anupam Hazra

Agriculture is the heart of rural economy for India. This sector provides gainful employment as well as raw materials for a large number of industries in the country. Off late, amid economic reforms and trade liberalization, considerable changes have been noticed in this sector. Looking at the core concerns of this sector, the growth of this sector in terms of increased public investment is of immense necessity at this juncture to revive the fate of the rural economy of India. Empirical studies, analyzing the association between agricultural growth and rural poverty confirm that the latter is inversely related to agriculture income per head. At the macro level, this inverse relationship points towards existence of a “trickle-down” mechanism of growth. However, rather than its mere existence, the working of trickle-down mechanism is essential, to be able to achieve any notable reduction in poverty, especially in rural India. Combating poverty is at the centre of Millennium Development Goals (MDG) and as per the World Development Report 2008, to

achieve these targets - nothing is more imperative than pro-poor initiatives in agriculture; which will be very much evident and can aptly be shown from the following discussion on how agriculture will pave the way for rural India to achieve its MDG-commitments:

Goal 1. Eradicate extreme poverty and hunger

Three quarters of the world's poor live in rural areas and make their living from agriculture. Agriculture and allied activities support livelihoods of nearly 70 percent of India's rural population. So it can eradicate poverty by creating livelihood opportunities for the rural poor and at the same eradicate hunger by promoting higher food availability.

Goal 2. Achieve universal primary education

Poor rural households often cannot afford to send their children to school. Parents generally prefer to engage their children in agricultural activities to save labor-cost of cultivation than sending them to school. Rising agricultural productivity will not allow the farmers to hire labor for agricultural activities but will also enable the rural parents to send their children to school.

Goal 3. Promote gender equality and empower women

For the rural women, the main source of their livelihood opportunities is confined within agriculture and its allied activities. Improvements in agriculture, is therefore, can contribute in a fundamental way to women empowerment by making them economically independent – which will ultimately provide the platform for gender equality.

Goal 4. Reduce child mortality

The problem of child mortality is a result of some combination of poor living conditions, including a deficient diet, and the quality of and accessibility to the health system. About half of all child deaths occur because of malnutrition, which prevents children from fighting off even common childhood ailments. Boosting food production through increased agricultural productivity and improving the quality of children's diets will help reduce child malnutrition and child mortality, especially in rural areas. Higher



incomes from agriculture-led economic growth will allow households to spend more on food and medicine, thus also leading to lower child mortality rates.

Goal 5. Improve maternal health

Agriculture can also benefit maternal health directly, by improving the quality of women's diets. Both the quality and the quantity of food available to women affect their health, and the impact of malnutrition on reproductive health is well documented. Maternal health also depends on having achieved food security in girlhood, well before conception. More than 65,000 women die of anemia each year. To overcome such health problems, we need to supplement diets and fortify foods with micronutrients and breed staple crops rich in these nutrients – which are only possible through a higher investment in agriculture.

Goal 6. Combat HIV/AIDS, malaria, and other diseases

A dynamic agricultural sector can reduce risky economic behavior, increase the demand for education and good health care, and provide adequate food for leading a healthy life and fighting illness if the need arises. A sluggish agricultural sector, on the other hand, can seriously undermine attempts to curb the spread of HIV/AIDS and other diseases. Stagnating agriculture can lead poor people to take dangerous risks and engage in economic activities that imperil health. Moreover, without proper food and nutrition, people living with HIV will transition to AIDS more rapidly, because individuals with HIV require up to 50 percent more protein and up to 15 percent more calories than healthy individuals. Overall, to attain the MDGs for diseases, the resources of the agricultural sector need to be coordinated with those of the health sector to meet the joint challenges of poverty reduction and disease eradication.

Goal 7. Ensure environmental sustainability

The Millennium Declaration targets a variety of environmental issues, including biodiversity, critical natural habitats, energy use, global climate change, safe water and sanitation, and urban slums. A productive agricultural sector can reduce pressure in all of these areas. In addition, various market failures in agriculture have been known to contribute to environmental deterioration. Some of the most prominent examples have to do with over exploitation of natural resources where property rights are not clearly assigned and where subsidies

encourage malpractice in resource management. Funds need to be diverted from eco-destructive subsidies to policies that strengthen the ecological foundations essential for sustainable agriculture.

Goal 8. Develop a global partnership for development

The creation of a global partnership for development will require increased commitments on the part of global and national actors to the pursuit of pro-poor growth. Supporting agriculture growth in low-income countries generally means supporting pro-poor growth, especially when combined with better access to markets by small farmers. So Policy actions that improve agricultural productivity and food and nutrition security are essential components of a successful MDG strategy—that requires a coordinated global effort.

Conclusion

India is predominantly a rural nation, with more than 70% of its population living in rural areas and lives primarily on agriculture; and moreover as per the prediction of United Nations Population Division (2008), this trend would not change at least in next 20 years, even with urbanization. In a predominantly agrarian rural community like India, the level and growth of agricultural production per capita of rural population is an important variable determining levels of welfare. So, modernization of agriculture should be given utmost priority as an integrated part of rural development policies, which entails investments in research and extension, as well as in infrastructure. A large part of modernization should include the adoption of high-yielding agriculture, anchored on modern varieties, intensive systems, and massive investments in irrigation. Agriculture-led development is the most obvious one for India and in this framework agriculture will always play the pivotal role; with the increase in the productivity of agriculture - industry and other sectors of rural economy is supposed to take off. At the same time, particularly for rural India improving the quality of life for its huge population - is an enormous and challenging task; if solutions to this problem are to be found within the rural area itself - then modernization and increased investment in agriculture is one of the most reliable way to accomplish this daunting task by bringing rural India closer to its MDG-commitments.

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EFFICIENT USE OF FERTILISERS CAN INCREASE AGRICULTURAL PRODUCTION

Dr. Yashbir Singh Shivay

Fertilizer has been the key input in augmenting food production in India. However, fertilizer use in India is skewed, high in a few states having adequate irrigation and dismally low in the North-Eastern states. There is also imbalanced use of N, P and K. Deficiency of secondary nutrient sulphur and micronutrient zinc is widespread in the country and boron deficiency is reported from the eastern states.

While attempts are being made to increase the fertilizer use in states where levels of application are low, the focus is on developing and promoting secondary and micronutrient fortified customized fertilizers. A serious thought needs to be given for increasing the use efficiency of nitrogen, which is very low, especially in rice. Therefore, more efficient nitrogen fertilizers, using low-cost nitrification inhibitors and coating materials need

to be developed and produced. Production and promotion of organic manures also needs due attention.

With the continuous and steady increase in the use of fertilizers and considerable escalation in their prices, the need to utilize every unit of plant nutrients in the most productive and profitable manner has become essential. Fertilizer use efficiency is determined by different group of professionals in different ways.

Three most commonly used terms are: (i) agronomic efficiency, (ii) physiological efficiency, and (iii) apparent recovery. Agronomic efficiency indicates increased economic product produced by the use of nutrient and is the one which is used in calculating fertilizer demands. Physiological efficiency and apparent recovery involve laboratory analysis of a



particular nutrient. Physiological efficiency denotes the kg grain or any other economic product produced by a kg of nutrient or any nutrient absorbed by the crop. Apparent recovery on the other hand expresses the amount of nutrient absorbed by the crop plant and is expressed as percentage of the total nutrient applied. One factor which is common for all is the crop yield. If yield is increased, fertilizer use efficiency (FUE) also automatically increases.

There are three ways by which fertilizer use efficiency can be increased: (A) by adoption of better agronomic package of practices, B) use of more efficient fertilizer materials, and (C) integrated nutrient management involving combined use of fertilizers, organic manures, bio-fertilizers, etc.

(A) Agronomic Approach

Agronomic practices such as choice of right crops and their varieties, right type of fertilizer, correct dose, appropriate time and method of fertilizer application and proper weed control and water management that result in increased yield also increase the fertilizer use efficiency.

Choice of Crop and Variety

In traditional agriculture the farmers practice subsistence agriculture and grow the crops they need for their direct use such as food-grains or forage. In many cases these crops are neither the agro-ecologically ideal nor the most remunerative ones. For example a study at IARI, New Delhi has shown that for Delhi region cotton is the most remunerative crop followed by pigeonpea during *kharif* season, while mustard and sunflower are more remunerative than the traditional wheat or barley during *rabi* season. Higher crop yields are possible with short-duration pigeonpea crop than pearl millet in *kharif* and with mustard than wheat or barley during *rabi* season in several parts of Haryana, Rajasthan, Uttar Pradesh and Madhya Pradesh under dry land conditions. Besides being more fertilizer efficient and remunerative, these new alternative crops would also help to overcome the present shortage of oilseeds and pulses in the country. Now, India has an array of high yielding varieties, hybrids and composites in cereals. Farmers are fully aware that these have very high yield potential compared to local ones.

But the potential of these can be realized only when adequate amounts of fertilizers are applied.

Choice of Fertilizers

Unlike organic manures, which supply slowly all the nutrients in very small quantity, specific fertilizer can meet the specific needs of the crop and soil as Yogic exercises (Asana) can take care of the specific need of the different parts of the specific need of the human body. Ammoniacal (NH_4^+) forms of nitrogen (ammonium sulphate, ammonium chloride etc.) are more efficient in waterlogged rice. Ammonium sulphate is more effective in sodic and S deficient soils. Sulphur containing fertilizer like SSP, ammonium sulphate and ammonium phosphate sulphate etc., can efficiently meet the higher need of S for oilseed crops particularly when grown in S deficient soils. Rock P is an efficient source of P in long duration crops like plantation which are generally grown in high rainfall areas dominated by acid soils. Zinc fertilizer (ZnSO_4) is more effective in sodic soils. Potassium sulphate is more effective in S deficient soils and high value crops like tobacco, potato and grapes. Plant nutrient cafeterias are to be identified to serve the specific needs of the crops.

Correct Dose of Fertilizers

Different crops need different quantities of nutrients. Soils differ in their capacity to provide plant nutrients to growing crops and the removal of different nutrients from the soil by various crops also varies considerably. Thus, for each crop the quantities of nutrients which should be used to produce the best yields will depend on its specific requirements and on the resources of the soils. State Agriculture Departments with the help of Agricultural Universities provide guidance to farmers as to the correct dosages of plant nutrients to be applied to various crops by publishing fertilizer recommendations. These general recommendations are based on experiments in Government farms and cultivators fields and are usually framed for each district. They are revised from time to time as more detailed and up-to-date data are collected and more experience gained. District wise fertilizer recommendations give useful guidance to farmers but naturally they are not tailored to meet specific

requirements of the soil in each farmer's field. It may well happen that by following the general recommendations a farmer may be applying too much of one plant nutrient and too little of another. The ideal way to fertilize a field is to apply fertilizers on the basis of actual requirements as ascertained by soil tests.

Fertilizer recommendations are never final. They are revised when changes in soils fertility arise. New crop varieties are continually being released and nutrient requirements of these varieties may be quite different from those currently in use. Higher crop yields need the application of higher levels of plant nutrients. Higher yields under intensive agriculture have resulted in the removal of secondary and micronutrients to such an extent that these have become deficient. Changes of soil fertility levels with continued fertilization also necessitates the revaluation of problem of rates of fertilizer application. Hence, there is a need for review of fertilizer recommendations on a continuing basis.

Time of Application of Manures and Fertilizers

a) Manures

Generally bulky organic manures like farmyard manure (FYM) or green manures should be applied ahead of sowing to ensure its thorough mixing with the soil by pre-sowing cultivation and to give it time to decompose so that the plant nutrients contained in it become available to the growing plants. Farmyard manure should, therefore, be applied 4 to 6 weeks before sowing or planting. The time for burying under of a green manure crop depends upon the stage of maturity of the crop and soil conditions. In case of rice, results from Central Rice Research Institute, Cuttack, indicated that eight week old dhaincha (*Sesbania aculeata*) buried immediately before transplanting gave similar yield response as when buried four to eight weeks before planting. Similar results have been reported from PAU, Ludhiana where coarse textured soils predominate. In case of a 12 week old crop, burying four to eight weeks before transplanting was advantageous in fine textured soil. This is due to the fact that young plants have tender tissues and are more succulent. They decompose quickly (in about a week's time) when incorporated in soil with an abundance of water, and behave like a

quick-acting fertilizer in supplying available nitrogen. Stem and woody portions of older plants, however, take more time to decompose and nitrogen contained in them becomes available to plants rather slowly. In this respect, they behave more like bulky organic manures, e.g., farmyard manure and compost.

For crops other than rice where sufficient moisture may not be present in the soil, green manure crop must be buried well in advance of sowing to allow plant material to decompose completely. Provided moisture conditions are adequate and green manure crop is in the succulent early flowering stage, a six to eight weeks' period is usually enough to completely decompose it.

b) Fertilizers

Time of fertilizer application may considerably influence crop response to fertilizer. A number of factors like nature of the crop, its growth stages and nutrient requirements or crop needs, soil conditions, nature of the fertilizer, etc., affect the time of fertilizer application. Fertilizers may be applied: (1) well before sowing the crop (2) at the time of sowing, and (3) after sowing the crop.

(1) Application well before sowing

Some phosphatic fertilizers like rock-phosphate, basic slag, etc., should be applied well before sowing to obtain maximum effect. These fertilizers contain phosphate in water insoluble form. In the soil they come in contact with soil acids which convert insoluble phosphate to soluble forms. As this process needs time, application of these fertilizers about 2 to 4 weeks before sowing is desirable.

(2) Application at the time of sowing

Application of fertilizers at the time of sowing or just before sowing is known as "basal application". Nutrient requirements of a crop differ considerably during different growth stages. A number of food crops, particularly cereals, require large quantities of nitrogen immediately after planting or sowing to establish themselves, at the time of tillering when new shoots are formed and at the time of flowering and grain formation. Utilization of applied nitrogen is

better if supply it at a time when crops need it most. It is advisable to apply a part of nitrogen at the time of sowing or planting and the remaining quantity in split doses during different growth stages of the crop.

Among major plant nutrients, nitrogen, particularly nitrate (NO_3^-) nitrogen, is most mobile. When there is excess of moisture in the soil, nitrate nitrogen moves quickly into lower layers and thus, may be lost. Nitrate containing fertilizers should, therefore, be applied when soil conditions are optimum and there is no excess moisture in the field. Ammoniacal nitrogen on the other hand is held by clay particles and becomes slowly available to plants. It is, therefore, not subjected to leaching losses. Phosphate promotes root development and thus, gives a good start for vigorous growth of plants. Plants require an adequate supply of phosphate during the early stages of growth. It has been estimated that by the time 20 per cent growth has occurred, plants would have taken up 50 per cent of their total phosphate requirements. Unlike nitrogen, phosphate is relatively immobile in the soil. The entire recommended quantity of phosphate can, therefore, be applied at the time of sowing.

Potassium uptake is more or less continuous throughout the different stages of growth. However, potassium uptake is more active during the early growth stages and it usually occurs faster than that of either nitrogen or phosphorus. It is relatively less mobile in the soil than nitrogen. Hence, like phosphorus, it may also be applied in full at the time of sowing, except in light soils where it may be applied partly as top-dressing also.

(3) Application after sowing

Application of fertilizers to standing crops is called “top dressing”. Usually, a part of nitrogen should be supplied to the standing crop depending upon the stage at which it is most required. For instance, a part of nitrogen for medium and long duration variety of rice should be applied at the stages of maximum tillering and flowering. In some cases, as in coarse textured soils, a part of the dose of potash is also recommended for application to the standing crop. In Kerala, for example, application of a part of nitrogen and potash is recommended as

top dressing for rice grown in the sandy loam soil of Alleppey district, as this area is likely to receive floods because of which the potash supplied as a basal dose may be partly or wholly washed away.

For perennial crops like fruit trees, lawns, etc., however, apart from basal dose of fertilizers given at the time of planting annual applications of nitrogen, phosphate and potash are necessary. In respect of micronutrients, where the deficiencies are well established in the soil under question, it is better to apply them at the time of sowing. However, in plantation crops like tea, or where micronutrients deficiency symptoms appear in the standing crop, they should be applied as foliar sprays.

v) Method of Application of Manures and Fertilizers

Organic manures are applied by broadcasting them over the field. It is a good practice to apply half the quantity of organic manure across the furrow and the remaining half along the furrow. This way each portion of the field is covered twice and a uniform distribution of manure is achieved. Some farmers cart manure and deposit it in small heaps for quite some time before spreading it over the field. This practice is not desirable. In these small heaps, organic matter is rapidly oxidized and a large amount of nutrients, particularly nitrogen, is lost in the air. Results of experiments carried out show that in temperate regions within a period of 14 days of storing FYM in a field, its effectiveness has been reduced by 50 per cent. Under Indian conditions of high temperatures, the losses are likely to be still higher. Hence, the manure should be spread soon after it is carted to the field.

Fertilizers can be applied by the following methods: (1) broadcasting, (2) placement, (3) foliar application, (4) aerial application, (5) injection, and (6) application through irrigation water.

(1) Broadcasting: Broadcasting refers to the application of fertilizers to an open field at the time of sowing or in the standing crop. This is mostly done by hand in India. In other countries, fertilizer spreaders are used. Broadcasting is effective when crops have a dense stand, plant roots permeate the whole volume of soil, large doses are applied and insoluble

phosphatic fertilizers such as rock-phosphate are used. It is most common method of fertilizer application in closely sown crops. Broadcasting of fertilizers has the following major drawbacks:

- a) Fertilizers broadcast all over the field may stimulate weed growth with the result that full benefit of fertilizers is not derived by the crops;
- b) By broadcast application, fertilizers come in contact with a large volume of soil and they are likely to be fixed to a greater extent than by placement method. This is particularly true in the case of water soluble phosphatic fertilizers like superphosphate;
- c) Broadcasting results in uneven application and uneven crop stand particularly where the quantity to be applied is small;
- d) In case of urea, broadcast application on a dry soil may result in loss of nitrogen due to volatilization.

(2) Placement

Placement of fertilizers means their being placed at a specific place in the soil with or without reference to the position of seed. It is commonly practiced under the following conditions:

- (a) To apply small quantities of fertilizers;
- (b) For application of phosphatic and potassic fertilizers;
- (c) When plants are spaced widely apart; and
- (d) When development of the root system is poor and soils have a low level of fertility.

Placement of fertilizers has definite advantages over broadcasting. When fertilizer is placed there is minimum contact between soil and fertilizer and thus, fixation of nutrients is appreciably reduced. Weeds all over the field cannot make use of the fertilizer. Residual response of fertilizers when placed is usually greater than when it is broadcast. As fertilizer is placed near the root zone, it becomes readily accessible to plants and is, therefore, more fully utilized. Loss-of nitrogen is greatly reduced. Being relatively immobile, phosphates are better utilized when placed. In case of heavy feeding short duration crops like potato, maize, etc., placement gives much better results than broadcast application.

Fertilizers may be placed at any of the following positions at the time of sowing:

- 1) In contact with seed, i.e. seed and fertilizer (phosphate) are drilled together.
- 2) By drilling at a suitable distance away from the seed: (a) below the seed, (b) to one or both sides of it, or by a combination of (a) and (b).

When fertilizers are applied to a standing crop, they can be placed by:

- a) Banding, i.e. placing fertilizer in bands to one (single band) or both sides of rows (double band). This is called "side dressing";
- b) Drilling in between rows;
- c) By spot placement, i.e. by placing it between plants. This is practiced in vegetable crops;
- d) By circular band (ring placement) away from the base of plants as in case of fruit trees.

No single method can be considered best for all the crops. The method of placement varies with the crop, fertilizer, weather and soils as detailed below:

1. Readily soluble nitrogenous fertilizers and potassic fertilizers prove harmful to germination if placed in contact with or too near the seed. Such fertilizers must, therefore, be applied at a suitable distance away from the seed. On the other hand, phosphatic fertilizers have no such adverse effect and give best results when placed in close proximity to the seed. In normal quantities, they can be drilled together with the seed.
2. Cereals have generally been found to be less adversely affected by contact or close placement than other crops, particularly legumes.
3. For quick growing shallow rooted crops, band placement has generally proved better than other methods. But for deep rooted crops, better results are obtained by fairly deep placement directly below the seed row.

Practical aspects of placement

Suitable power drawn drills combining sowing and fertilizer placement (seed-cum-fertilizer drill) are

now extensively used in foreign countries to place fertilizers in bands in any desired position in relation to the seed. In India also seed-cum-fertilizer drills (mainly bullock drawn) have been developed and are being increasingly used. However, a fairly accurate job of fertilizer placement can also be done with an ordinary *desi* plough or a multi-tined hoe. Two types of placements commonly practiced are:

- 1) **Fertilizer placed directly below and few centimeters deeper than the seed;**
- 2) **Fertilizer placed in bands, 5 to 6 cm to the side, and 2.5 to 5 cm below the seed level.**

Single band placement directly below the seed is easy to achieve with a *desi* plough. All that a farmer has to do is to drop the fertilizer through a drill (*pora*) tied behind the plough and sow the seed, by dibbling (*kerā*) in the opened furrow. The furrows are subsequently closed by a plank. This ensures a layer of soil 2.5 to 5.0 cm thick between the fertilizer band and the seed. The germination of seed is, therefore, in no way affected by fertilizer. This method of placement is commonly called “plough sole placement”. It has generally proved better than broadcasting, but in some crops it is less effective than double band placement.

Double band placement is not possible with a *desi* plough. For this, a three to five tined cultivator in which tines are adjustable for distance between the tines as well as for depth can be very successfully employed.

(3) Foliar application

Foliar application is a method by which fertilizers are applied on the foliage as a solution. In recent years considerable progress has been made in spraying solutions of fertilizer materials on crops. Several nutrient elements, when dissolved in water and sprayed on leaves are readily absorbed by them. In general, nitrogen and micronutrients are applied as foliar sprays. The concentration of the spray solution has to be carefully controlled; otherwise serious damage may result due to scorching of the leaves. It should also be noted that crops differ in their tolerance to concentration of the spray solution. No general recommendations can, therefore, be made except that for most nutrients, **concentration**

of the spray solution should not exceed three to five percent, when conventional high volume sprayers are used. However, with low volume sprayers a higher concentration of up to 20 per cent can be used. In the case of nitrogen, organic forms like urea are much safer and less likely to cause leaf injury.

Spray fertilization is usually more effective for the application of micronutrients such as iron, copper, boron, zinc and manganese. As very small quantities of these elements are required by plants, they can be more effectively and economically applied as sprays. Sometimes insecticides are also applied along with fertilizers as foliar application. This is quite common in plantation crops like coffee, tea, etc.

(4) Aerial application

Aerial application of solid fertilizers or fertilizer solutions by aeroplanes is extensively practiced in USA, Australia, New Zealand and other countries where large continuous areas are to be fertilized. Materials are applied by aircraft particularly in hilly region, in forest lands, in grass lands, or in rice fields, where ground application is not practicable.

(5) Injection into soil

Liquid fertilizers for injection into the soil may be of either pressure or non-pressure types. Non-pressure solutions are applied either on the surface or in furrows without appreciable loss of plant nutrients under most conditions. On the other hand, anhydrous ammonia and low-pressure solutions (solutions with free ammonia) are injected into the soil at a depth of 10 to 15 cm and covered immediately to prevent loss of ammonia.

(6) Application through irrigation systems

In irrigated areas of several agriculturally advanced countries it is common practice to apply fertilizer through irrigation water. Though water soluble solid fertilizers, acid (phosphoric acid) etc. can be applied through this system, the most commonly prevalent method involves the use of fertilizer solution. Liquid fertilizer materials are introduced into irrigation water by means of gravity flow or under pressure. Various metering devices are employed to ensure uniform distribution. In order to prevent or reduce the precipitation of insoluble

carbonates in the irrigation water a small amount of polyphosphate is added as a water conditioner.

(7) Application through drip irrigation system

The drip irrigation system which provides frequent irrigations and maintains low soil moisture tensions is most suitable for proper supply of fertilizer to the crop. Therefore, the best performance of nitrogen fertilizer may be obtained if it is applied through drip irrigation system especially to the vegetable crops.

vi) Weed Control

Weeds compete with crop plants for water, light and nutrients. Timely and appropriate weed controls greatly improve the crop yield and FUE. It is reported that optimum dose of N for wheat at Saharanpur (U.P.) without weed control was 120 kg N/ha for a yield of 33 q/ha, while with the use of Tribunil only 92 kg N/ha for a yield of 54 q/ha was adequate. Thus, it demonstrates that effective weed control increases yield and FUE substantially.

vii) Water Management

Water is crucial for plant life. FUE is, therefore, high when adequate soil moisture is available. Under dryland conditions, one life saving irrigation can almost double the FUE on coarse textured red soils and increases even on heavy black soils. In irrigated agriculture, the results of a number of studies demonstrate that the FUE increases as the amount of irrigation increased to optimum.

(B) More Efficient Fertiliser Materials

Considerable research has been done on development and evolution of new fertilizer materials for increasing FUE in India. The promising materials are: urea super granules (US G), neem cake mixed/coated urea, urea mixed with gypsum and urea coated with rock phosphate. Recommendations for some of these materials in specified situations are mentioned (Table 1).

(C) Integrated Nutrient Management

The complementary use of fertilizers and organic and biological sources of plant nutrients has

been found to increase the efficiency of fertilizers as well as that of organic manures. For example, at Ludhiana application of 12 tonnes of FYM and 80 kg of nitrogen/ha produced more yield of rice than 120 kg N/ha alone. This also resulted in a residual effect on succeeding wheat crop equivalent to 30 kg/ha each of N and P_2O_5 .

Tips for Efficient Use of Manures and Fertilizers

The steps (package of practices) outlined below will contribute to enhancing overall efficiency of applied fertilizers through maximizing agricultural production from every unit of nutrient used.

- 1) Select the most responsive and best suited crops and their varieties for the locality.
- 2) High yielding varieties of crops give higher yields than local varieties without fertilization as well as higher unit response to fertilizers, even at the lower rate of application. Therefore, high yielding varieties should be grown wherever possible.
- 3) Planting/sowing of crops should be done at the normal time suited for the locality to get the benefit of maximum efficiency of applied fertilizers. As for example, if the planting of rice is delayed beyond July 15, for the same input of fertilizers, yield is reduced by 2 to 3 quintals per hectare per day.
- 4) Ensure proper plant spacing. In general, higher yields are obtained under a similar level of fertilizer application where plants are planted with closer row spacing - for *kharif* rice follow a spacing of 15 cm between rows and 10 cm between plants within a row and for *rabi* rice, follow a spacing of 10 cm x to 10 cm.
- 5) It is desirable to properly conserve and use all organic waste materials in the farm to build soil fertility and its water holding capacity, and for supplying micronutrients. They should be incorporated 3 to 4 weeks before sowing the crop. It is preferable to apply farmyard manure in the *kharif* season.
- 6) While using compost made from straw and dry leaves (having higher C: N ratio), it will be necessary to add a small quantity of

nitrogenous fertilizers to the compost so that nitrogen availability to the crop in the initial stages of its growth is not adversely affected. This is particularly true when a crop is sown within a short time of compost application.

- 7) The introduction of leguminous crops in diverse rotational and inter-cropping system and use of bacterial and algal cultures play a very important role in meeting the fertilizer need of the crop. The leguminous crops have the unique capacity of not only fixing the atmospheric nitrogen in the soil but also have the ability to utilize non-available native soil phosphorus.
- 8) To the extent possible, irrigation rate should be controlled by using just enough water at different physiological growth stages, as recommended for the crop being grown. Excessive irrigation leads to leaching losses of N and K to a large extent. Under water-logged condition also a large quantity of nitrogen is lost in gaseous form. Therefore, it should be ensured that there is not excess water in the soil at the time of fertilizer application and immediately thereafter. This is particularly true of urea which should be applied only in drained field (moist soil). Subsequent irrigation should be applied only after 24 to 48 hours.
- 9) Crop response to applied fertilizer phosphate is more in dry (*rabi*) season than in wet (*kharif*) season particularly where a rice-wheat cropping system is practiced. It is preferable in this situation to apply phosphatic fertilizer, based on soil text, to the *rabi* season crop.
- 10) Balanced fertilization (ensuring adequate availability of nutrients to the growing crop from the soil as well as the fertilizer including micronutrients) should be practiced based on the soil test. Fertilizer recommendations should preferably be based on cropping system where multiple cropping is practiced and not on individual crop basis.
- 11) While all of the phosphates and part or all of the potash should be applied as a basal dressing, nitrogen should be applied in 2 or 3 split doses keeping in view the duration of the crop, crop needs according to its physiological growth stages and soil moisture availability. However, under special soils and cropping situations like sandy soils having low CEC, alkaline soils, late maturing varieties of crops and coarse textured soil in high rainfall areas split application of potassium may be advantageously followed.
- 12) Phosphate should be placed 2.5-5 cm below and 5-6 cm away from the seeds to ensure maximum availability to the crop for which it is applied. Potash should be placed either along with phosphate or be broadcast and mixed with the soil. In dry soil, fertilizers should be placed only in the moist zone. Top-dressed nitrogen and potash fertilizers should preferably be mixed with the top layer of soil.
- 13) Urea should be cured with soil for top-dressing to reduce nitrogen losses by mixing one part of urea with 5-10 parts of moist soil thoroughly and keeping it for about 24 hours.
- 14) Under adverse soil and climatic conditions (wherever possible) application of fertilizers through foliage along with insecticides and pesticides (if needed) will lead to higher utilization efficiency by plants.
- 15) Deficiency of zinc is becoming more widespread. In such cases apply 10-50 kg of zinc sulphate per hectare through soil as basal application.
- 16) When the soils are acidic, saline or alkaline, appropriate amendments viz. lime (for acidic soils), gypsum (for alkali soils), etc., should be applied before using fertilizers.
- 17) Weeds, if not effectively controlled during the early stages (9-21 days) of crop growth, take away about 25-30 per cent of plant nutrients applied to the crops. Therefore, it is necessary to control the weeds particularly during the early stages of crop growth.
- 18) Proper control of pests and diseases is a must for realizing maximum effectiveness from fertilizers.
- 19) Efficient use of fertilizers involves adoption of all improved agronomic practices to raise a good crop and increased productivity.

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INCREASING AGRICULTURE PRODUCTIVITY IN RAINFED AREAS

Dasharath Prasad and Heerendra Prasad

Mulching is a useful practice in rainfed areas for controlling erosion, weed growth, reducing runoff and conserving moisture as well as improving soil properties like increased total porosity, available water content, soil aggregation, moisture content at field capacity, improvement in bulk density, also increase the soil organic carbon and beneficial soil microbes that result increase soil fertility, water use efficiency and crop productivity. Legume mulching is a highly beneficial practice for enhanced moisture and nutrient conservation, leading to increased productivity and soil health.

Rainfed agriculture, where crop production is exclusively dependent upon rainfall, covers about 80% of the world's crop land and produces world's cereal grains (more than 60%) but also generates livelihood in rural areas. Out of 143 m ha of cultivated area in India, 67% is rainfed. Rainfed agriculture extends over 97 million hectares of which nearly 67 m ha falls in the mean annual precipitation range of 500-1000 mm in India. About 91% area of coarse grains, 91% pulses, 80% oilseeds, 60% cotton, 50% rice and 19% wheat in India is produced solely from *rainfed* lands of which 43% share is through dryland.

Hence, rainfed areas will have to be the focus of India's future agriculture revival with a different paradigm of development and upgrading rainfed agriculture promises large social, economic and environmental paybacks, particularly in poverty reduction and economic development. The climates of drylands are characterized with arid or semi-arid types where there is less rainfall (less than 75 cm) and higher potential evapo-transpiration (PET). In dryland there is moisture induced drought at any stage of crop growth and hardly 75-120 days growing periods.

The primary constraints to agricultural



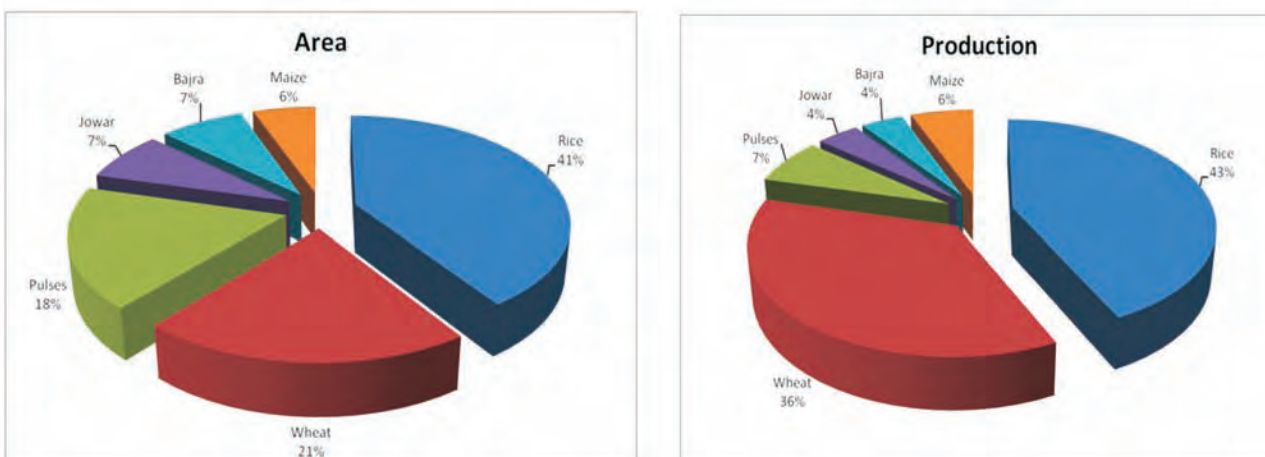


Fig.1 Relative area and production of food grains (%) in rainfed areas in India

productivity in dryland areas are the lack of suitable technologies for soil and water management because these are the highly fragile ecosystem and the global climate change has posed the acute problems in these areas more recently. Drylands are not only thirsty but hungry too. Hence, saving single droplet of water and maintaining fertility levels will be beneficial for which use of transpiration suppressants and mulches could be sustainable.

India needs 325 mt of food grains for 1.5 billion populations by 2025 for which the annual progression of food grains growth would be 7.3 million tons/per year. To meet the demand of cereals, legumes and oilseeds by 2030 over the 1994-96 bases, there is real need of 38-45%, 64-76% and 40-48% increment in production, respectively. Therefore, the rainfed/dryland area should be properly utilized to achieve the second green revolution in India. The average yield of coarse grains growing in rainfed lands is far below (0.88 t/ha) than the irrigated crops (2.0 t/ha) and same is the case with cotton, pulses and oilseeds. Hence, minimizing the huge yield gaps is the major concerns of the agronomists.

Rainfed Agriculture: Key Issues

The farmers in dry areas will suffer the most from climate change and will require a range of coping strategies to adapt to changing climates. Strategies will consist of changing of cropping systems and patterns, switching from cereal-based systems to cereal-legumes and diversifying

production systems into higher value and greater water use efficient options. The latter include judicious use of water using supplementary irrigation systems, more efficient irrigation practices and the adaptation and adoption of existing and new water harvesting technologies. The productivity levels of dryland crops like millets, pulses and oilseeds at farmers' level still remain low at about 1.0 t/ha although large number of technologies developed by the National Agricultural Research System showed that yields up Climate Change and Rainfed Agriculture to two tones can be achieved on farmers' fields. These yield gaps are largely due to a number of bio-physical and socio-economic constraints. Primary among them are weather uncertainties in drylands and degraded soils. Aberrations in South-West monsoon which include delay in onset, long dry spells and early withdrawal, all of which affect the crops, strongly influence the productivity levels. Soils in drylands are not only thirsty but also hungry. Wide spread deficiencies of macro and micro nutrients occur due to loss of nutrients through surface soil erosion and inadequate nutrient application. Mulching is a useful practice in rainfed areas for controlling erosion, weed growth, reducing runoff and conserving moisture as well as improving soil properties like increased total porosity, available water content, soil aggregation, moisture content at field capacity, improvement in density and beneficial soil microbes that result increase in soil fertility, water use efficiency and crop productivity.



Fig. 2 Wheat Crop at milking stages

- Problems of crop production in dryland areas
- Inadequate and uneven distribution of rainfall
- Late onset and early cessation of rains
- Prolonged dry spells during the crop period
- Low moisture retention capacity
- low fertility of soils

What is mulching

Mulching is one of the most important ways to maintain healthy landscape plants. Mulch is any material applied to the soil surface for protection or improvement of the area covered. Mulching is really nature's idea. Nature produces large quantities of mulch all the time with fallen leaves, needles, twigs, pieces of bark, spent flower blossoms, fallen fruit and other organic material.

Benefits of Mulching

When applied correctly, mulch has the following beneficial effects on plants and soil:

- Mulches prevent loss of water from the soil by evaporation.
- Mulches reduce the growth of weeds, when the mulch material itself is weed-free and applied deeply enough to prevent weed germination or to smother existing weeds.
- Mulches keep the soil cooler in the summer

and warmer in the winter, thus maintaining a more even soil temperature.

- Mulches prevent soil splashing, which not only stops erosion but keeps soil-borne diseases from splashing up onto the plants.
- Organic mulches can improve the soil structure. As the mulch decays, the material becomes top soil. Decaying mulch also adds nutrients to the soil.
- Mulches prevent crusting of the soil surface, thus improving the absorption and movement of water into the soil.
- Mulches prevent the trunks of trees and shrubs from damage by lawn equipment.
- Mulches help prevent soil compaction.
- Mulches can add to the beauty of the landscape by providing a cover of uniform colour and interesting texture to the surface.
- Mulched plants have more roots than plants that are not mulched, because mulched plants will produce additional roots in the mulch that surrounds.

Types of Mulches

There are basically two types of mulches: **organic** and **inorganic**.

Organic Mulch Organic mulch is mulch made of natural substances such as bark, wood chips, leaves, pine needles, or grass clippings. Organic

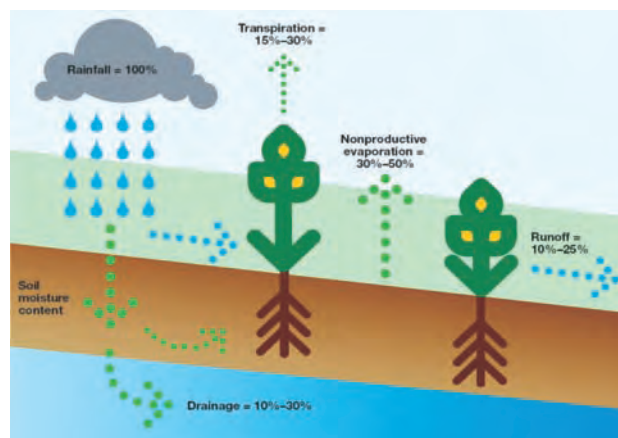


Fig 3. Distribution of rainfall

mulches attract insects, slugs, cutworms and the birds that eat them. They decompose over time and need to be replaced after several years.

Inorganic Mulch Inorganic mulches, such as gravel, pebbles, black plastic and landscape fabrics, do not attract pests and they do not decompose.

Both types may have their place in the garden. Mulching with plant materials reduces soil loss up to 43 times compared to bare soil and 17 times compared to cropped soil without mulches. Various types mulching have been practiced for rain water conservation as follows-

- i. **Straw mulch:** - Straw mulch consists of placing a uniform layer of straw and incorporating it into the soil with a studded roller or anchoring it with a tackifier stabilizing emulsion. Straw mulch protects the soil surface from the impact of rain drops, preventing soil particles from becoming dislodged.
- ii. **Stubble mulch:** - It is leaving the organic residue of the crop that is not gathered during harvest on the ground. It allows for cooler soil and less erosion. An example of this would be leaving the wheat straw in the field after harvesting the heads for grain.
- iii. **Dust mulching:** - Thoroughly pulverized surface soil, created by cultivating around plants, which is dried almost at once by sun and wind. Capillary water beneath this mulch cannot penetrate the dust layer and escape into the air. Thus dust mulch conserves water at the plant roots, just as any other mulch does.
- iv. **Plastic mulch:** - It is completely impermeable to water; it therefore prevents direct evaporation of moisture from the soil and thus limits the water losses and soil erosion over the surface. In this manner it plays a positive role in water conservation. The suppression of evaporation also has a supplementary effect; it prevents the rise of water containing salt, which is important in countries with high salt content water resources.
- v. **Vertical mulching-** Sub soiling for breaking of hard pan by sub soiler. It increases the root penetration, aeration, and water percolation. This is mostly practiced in coffee garden.

Organic Mulch Materials

Yard “trash” can be recycled as mulch with the advantage of retaining the nutrients found in these organic materials, in addition to saving money otherwise spent in transporting and disposing of the yard trash.

➤ Grass Clippings

The best use for grass clippings is to leave them on the lawn. Grass clippings will decompose rapidly, adding nutrients back into the soil. A two-inch layer of grass clippings provides weed control if they are not full of weed seeds. It is best to build up the layer gradually using dry grass, not fresh clippings, to prevent the formation of a solid mat. Be careful not to use clippings from lawns that have been treated with herbicides.

➤ Hay and Straw

Never use hay for mulch since it contains too many weed seeds. Straw decomposes rapidly, so you will have to replenish it to keep the weeds down. Straw is not very ornamental and is best for a vegetable garden or over newly sown lawns. Straw will improve the soil as it decays.

➤ Leaf Mold

Leaf mold has a tendency to form a crust, preventing water from penetrating into the soil. It is better to use leaf mold as a soil amendment than as mulch.

➤ Leaves

A 2- to 3- inch layer of leaves provides good weed control. It is best to shred the leaves coarsely, using a shredder or your lawn mower. Whole leaves have a tendency to blow away, while finely shredded leaves do not allow water to penetrate. Oak and beech leaves help to acidify the soil for acid-loving plants. Leaves are usually easy to get, attractive as a mulch, and they will improve the soil once they decompose. After the

leaves decompose, dig them into the soil and add a new layer of mulch on top.

➤ **Pine Bark**

A 2- to 3- inch layer of pine bark is good for weed control. Pine bark makes attractive, usually dark-colour mulch. It can be purchased in various particle sizes, from shredded to large-sized particles, called nuggets. Large pine bark nuggets float in water and may not stay in place during a heavy rain. They may also attract termites and other insects.

➤ **Pine Needles**

A 2- inch layer of pine needles makes excellent mulch for acid-loving trees and shrubs. This mulch is very attractive and allows water to penetrate easily.

➤ **Shredded Hardwood Mulch**

This mulch is good at suppressing weeds. It does not wash away easily. It decomposes relatively slowly, and it is very attractive.

➤ **Wood Chips**

This material contains bark and pieces of wood of various sizes and makes attractive mulch. A 2- to 3- inch layer of wood chips provides good weed control. Small wood chips decompose very rapidly using nitrogen from the soil, which needs to be replaced by nitrogen fertilizer. Wood chips may attract termites and other insects.

➤ **Pecan Shells**

Pecan shells make a long-lasting, attractive, dark brown mulch that is effective in retaining moisture in the soil. Availability is usually limited to areas where pecans are processed.

➤ **Ground Cover**

Many perennial ground cover plants, such as ivy, periwinkle, pachysandra, mondo grass and liriopse, will cover the soil and act as mulch.

Inorganic Mulch Materials:

➤ **Gravel, Pebbles and Crushed Stone**

These materials are permanent and are best

used for permanent plantings such as foundation plants. A 1- inch layer of small rocks will provide good weed control. Do not use them around acid-loving plants since the rocks may add alkaline elements and minerals to the soil. These materials reflect solar radiation and can create a very hot landscape environment during the summer months.

➤ **Plastic Mulch**



➤ **Black Plastic**

Black polyethylene film is very effective in preventing weed growth. It also holds water in the soil. Therefore, plastic is not recommended for poorly-drained areas as it may cause the soil to remain too wet, which could result in root disease problems. You may have to cut holes in the plastic if water does not go through it. There is black plastic available that has small holes in it to help with drainage. If exposed to sunlight, black plastic is broken down fast, losing its effectiveness as a mulch. However, if you bury black plastic in the soil, it will last for many years. Covering the black plastic with a layer of wood chips or pine needles will reduce heat absorption and mask its artificial appearance.

➤ **Clear Plastic**

Clear plastic will not suppress weed growth because light penetrates the film and raises the soil temperature, which may result in an increased growth of weeds in early spring.

Characteristics of polyethylene film

- It should be relatively cheaper
- Resistant to biochemical degradation
- Toughness and flexibility
- Allow low water vapor permeability
- Good transparency
- Free from toxicity
- Thickness 25-50 μm , density is 0.92 g/cc.
- **Landscape Cloth or Woven Ground Cloth**

Materials woven of fabric, plastic or paper are available in various lengths and widths. The materials are treated to resist decomposition. Unlike plastic films, woven materials allow water and air to move through them. They are very effective in controlling most weeds, although some grasses may grow up through the holes in the fabric. Landscape cloth needs to be fastened down so it will not be pushed up by perennial weeds. Better moisture, temperature and weed

control will be obtained by adding several inches of another mulching material on top of the landscape cloth.

➤ **Aluminum-coated plastic and foil**

One layer of either one of these materials provides excellent weed control. These materials decompose very slowly, but they are very expensive and quite unattractive mulches.

➤ **Ground Rubber Tires**

Mulches made of ground rubber tires do not decompose and therefore, never need to be replaced. The use of ground rubber tires is relatively new and its effectiveness as a mulch is still being evaluated.

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AGRICULTURAL DEVELOPMENT THROUGH HORTICULTURE IN NORTH-EAST INDIA

Lakshmi Dhar Hatai

Horticulture is the fastest growing sector within agriculture contributing towards improving farm incomes, enhancing food and nutritional security, reducing rural poverty and accelerating the overall economic growth of the NEH region. The NEH Vision 2020 places considerable emphasis on enhancing agricultural growth through technological change, area expansion, cropping intensity and value addition by attracting private investment in agro-processing (Government of India, 2008). It is estimated that high-value horticultural crops such as, fruits, vegetables, condiments and spices occupy as much as 15 per cent of the region's gross cropped area. For instant, the growing demand for horticultural products especially burgeoning market for processed fruits and vegetables as well as booming floriculture market is an evidence of the scope for accelerating horticultural growth in NEH region. Horticulture has become a sustainable and viable commercial venture for the marginal and small farmers of this region. Therefore, there is

ample scope for triggering agricultural development through horticultural interventions (Singh, 2009).

NEH region: North-East India is endowed with diverse agro-climatic conditions, rich genetic diversity and vast natural resources that offer a great scope to develop agro-ecosystem specific technological interventions for diversification of hill agriculture and allied activities. Our NEH region displays a distinct ethnic, socio-cultural and economic features, geographical identity with climatic variability separate the hill agro-ecosystem from the rest. About 80 per cent of the people are dependent directly or indirectly on agriculture for their livelihood. However, agriculture is the dominant activity in hill economy, which is basically of complex, diverse, multiple risk prone and uncertainty. The North East Region (NER) covers an area of 2,62,180 km geographical area. The net sown area and gross cropped area of this region is 38.39 lakh ha. and 53.49 lakh ha. respectively. Due to diverse regional typologies, difficult terrain, in accessible habitation, marginality, fragility, extreme



vulnerability to natural events, poor infrastructures, distinctive gender dimensions, only 2.21 per cent of total geographical area in Arunachal Pradesh, 5.17 per cent in Mizoram is under cultivation while in Manipur, Meghalaya, Nagaland it is 6.26, 9.18 and 12.72 per cent respectively. However, in Assam it is 35.07 per cent.

Potential of Horticulture: The NER has immense scope for horticultural development. Horticulture is the main economic activity in NE region. This region is abounding in crops like Banana, Pineapple, Cashew nut, Orange, Citrus, Passion fruits, Kiwi, Plums, Pears, Peaches, Ginger and Turmeric etc. which have high commercial value. Passion fruit cultivation is of special importance to Mizoram, Nagaland, Manipur and Sikkim which has good for exports. Kiwi fruit is being cultivated in Arunachal Pradesh, Sikkim, Meghalaya and hills of Manipur. North-eastern region is blessed by nature with tremendous biodiversity and extremely congenial climate for growing various kinds of ornamental crops (anthurium, gerbera, roses, heliconia, carnations, lilioms and orchids etc.).

Share of high-value crops in gross cropped area, (2004-05)

(Per cent)

NEH Regions	Fruits	Vegetables	Condiments and spices
Arunachal Pradesh	13.7	7.2	2.5
Assam	2.9	4.6	3.4
Meghalaya	8.3	13.6	7.8
Manipur	11.9	7.0	5.2
Mizoram	16.8	5.4	8.8
Nagaland	7.5	6.9	2.2
Tripura	8.3	9.2	2.5
North-east	5.1	5.8	3.7

Source: www.mospi.gov.in

During 2001-02, Govt. of India launched the centrally sponsored scheme on Technology Mission for integrated development of horticultural sector, which focused in area coverage, quality production and creation of post harvest facilities in NER. Horticulture has got a major boost with the launch of National Horticulture Mission in 2005, in which major steps taken towards a planned approach for development of horticultural sector in NE India. Moreover, Rs. 1,850 crore has been allocated for implementation of National Horticulture Mission and Horticulture Mission on North-East and Himalayan States in 2012-13. Meghalaya has occupied maximum

area in pineapple (9.5 thousand ha.) followed by citrus (8.2 thousand ha.) and banana (6.2 thousand ha.). It is one of the leading state of producing quality turmeric, ginger, cashewnut and strawberry as well as commercial floriculture (rose, liliom, anthurium, carnations, birds of paradise etc.). Assam state has maximum area under vegetable and fruit cultivation of 331.4 thousand ha. and 118.5 thousand ha. respectively, where as Mizoram has lowest area of vegetable cultivation of 1.7thousand ha. and Sikkim has occupied lowest area of 9.0 thousand ha. in fruit cultivation.

The NE region has got tremendous scope for development of horticultural interventions. The state of Meghalaya has the speciality of ginger and turmeric, fruits and variety of vegetables (pineapple, squash, kidney beans), Medicinal and aromatic plants (MAP), high value crops (passion fruits, citronella, lemongrass and pachuli etc) are some of the niche commodity having ample scope to reap the uncommon opportunity. The innovative and holistic approach to development is needed for local ecologies, institutions, people and resources in NER. In The great concerns are the efficiency, growth, equity and sustainability in horticulture in this region. For enhancing efficiency of agriculture in NER, there is need of improved and innovative technology to raise production and productivity of horticultural produce. To meet the domestic as well as international quality standards, upgradation, post-harvest marketing operations, e.g. harvesting, cool chain, packing and transportation have to be improved. There is necessity of developing linkages between the farmers and market for achieving better remunerative prices. The National Horticulture Board (NHB), Agricultural and Processed Food Products Export Development Authority (APEDA), Ministry of Food Processing Industries (MOFPI), National Cooperative Development Corporation (NCDC) and North Eastern Regional Agricultural Marketing Corporation (NERAMAC) etc. should give more importance on the commercial horticultural production and management of post-harvest related infrastructural facilities at various levels of operation in NEH region.

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CLIMATE CHANGE-IMPACT ON AGRICULTURE

Shabir Ahmad Padder

Climate change is perhaps the biggest challenge facing the world today, and the very existence of man depends on how effectively this challenge is tackled. All with this phenomenon, which threatens to play havoc with the lives of People across the globe. Our health, agriculture, habitation, everything depends on how effectively we are able to tackle this problem.

Climate and Agriculture are interrelated processes, both of which take place on a global scale. Global warming is projected to have significant impacts on conditions of affecting agriculture, including temperature, precipitation and glacial run-off. These conditions determine the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals. Rising carbon dioxide levels would also have effects, both detrimental and beneficial, on crop yields. The overall effect of climate change on agriculture will depend on the balance of these effects. Assessment of the effects of global climate changes on agriculture might help to properly anticipate and adapt farming to maximize agricultural production.

Recent scientific evidence suggests that India will be one of the countries that will suffer most from climate change. Food production and food security, fresh water supply, forest biodiversity, coastal settlements, fishing and more will be adversely affected. Unfortunately; the burden of climate change will fall disproportionately on poor communities, namely dry- land farmers, forest dwellers and fishermen. According to the report of the Lehman Brothers January, 2007, India will be the biggest loser; it projected an estimated gross domestic product loss of 5% owing to climate change.

The impact of climate change on the poorest people, which may exceed five hundred million in India, is rarely the central issue in all the debates on climate change. The central issue for policy makers seems to be the likely impact of any climate mitigation measures on economic growth.

However, economic growth alone will not insulate the poor against the adverse impact of climate change. High growth rates in the past decade have not made any significant impact on the quality of life of the poor. The poor in India are already exposed to severe water scarcity, water pollution,



fodder and fuel wood scarcity, land degradation desertification, droughts and floods. Unable to cope with the current Environmental stresses such as drought and water stress, the poor will be vulnerable to climate change and will find it difficult to adapt. India needs to chart multiple strategies to cope with the impending threats of climate change, which are additional to the existing environmental stresses. This should include i) Research for an improved understanding of climate change – related issues; ii) The adoption of sustainable development pathways; iii) Increasing the adaptive capacity of the poor; and iv) Working towards a global arrangement to reduce ambitions of green house gases at the earliest. Any delay in action to address the climate change will make future actions more expensive and even more difficult to agree upon.

Green House Gases (Emission from Agriculture)

The agricultural sector is a driving force in the gas emissions and land use effects. In addition to being a significant user of land and consumer of fossil fuel, agriculture contributes directly to greenhouse gas emissions through practices such as rice production and the raising of livestock (FAO, 2007). According to IPCC, the three main causes of the increase in greenhouse gases observed over the past 250 years have been fossil fuels, land use, and agriculture. Agriculture is itself responsible for an estimated one third of global warming and climate change. It is generally agreed that about 25 per cent of the main greenhouse gas, carbon dioxide, is produced by agricultural sources, mainly deforestation and burning of biomass. Most of the methane in the atmosphere comes from domestic So mains forest fires, wetland rice cultivation and waste products, while conventional tillage and fertilizer use account for 70 per cent of the nitrous oxides. The Food and Agriculture Organization has estimated that meat production accounts for nearly a fifth of global greenhouse gas emissions. These are generated during the production of animal feeds. Ruminants particularly cows, emit methane which is 23 times more effective as global warming agent than carbon dioxide.

Impact on Agriculture

Agriculture will be impacted by climate change

in several ways. There will be reduced crop yield. For example, an increase of temperature from 1 to 4°C can reduce grain yield of rice by 0-49% potato by 5-40%, green gram by 13-30% soya bean by 11-36%. Climate change can shorten rabi season and decrease yield. Vulnerability to diseases and pest attack increases. High temperatures affect the quality of produce. Increase in temperature can reduce 1000 grain weight and the amylase content and also adversely affected grain elongation and aroma in basmati.

Increase in temperature causes distress to dairy animals affecting milk production. Studies indicated that India loses 1.8 million tones of milk production due to climatic stresses.

Crop Productivity Livestock

Climate change will affect the health, growth and productivity of crops, livestock, fish, forest and pasture in different ways. It will also have an impact on the incidence of pests and diseases, biodiversity and ecosystems. Frequent changes in weather parameters, more importantly temperature and precipitation would not only threaten food production but also access stability and utilization of food resources Livestock and livestock-related activities such as deforestation and increasingly fuel-intensive farming practices are responsible for over 18% of human-made greenhouse gas emissions Important measures call for significantly increases in rural investments to reduce the long term effects of short term climate variability on food security, through provision of crop and livestock insurance and incentives that encourage farmers to adopt farm and social forestry, conserve resource and better agricultural and land use practices.

Impact on Fisheries

In the short term, climate change is expected to affect fresh water fisheries through changes in water temperature, nutrient levels and lower dry season water levels which in turn will have impact on quality, productivity, output and viability of fish and aquaculture enterprises, thereby affecting fishing community. Dry season flow rates in rivers are

predicted to decline in south Asia and in most African river basins, leading to reduced fish yields, according to the FAO. In the longer term, larger changes in river flows are anticipated as glaciers melt, reducing their capacity to sustain regular and controlled water flows. Researchers found that lake fisheries have already begun to feel impact of climatic variability, affecting fish production.

Impact on Hydrology and Water Resources

Climate change will affect drinking, irrigation and hydro power production. It will have an impact on the predictability and variability of water and also increase in frequencies of droughts and floods. Climate change will accelerate damage to fresh water eco system such as lake & marshes & rivers, Hill side, Stone slide, problems in water shade management. By 2050 Annual run-off the Brahmaputra is projected to decline by 14% and Indus by 27%. Sea level rise will effect ground water aquifers. Ocean chemistry is changing more than 100 times rapidly than it was during last 2100 years. Since industrial revolution, oceans have become 30% more acidic and the sea fish is under threat. More floods will degrade drinking water, damage crops, and livestock. Climate change related melting of glacier could seriously effect half billion people in the Himalaya-Hindu– Kush region, a quarter billion people in china, depending on Glacier melt for water supplies. India, China and Bangladesh are especially susceptible to increasing salinity to ground water and surface water resources especially along the coast , due to increase in sea level as a direct impact of climate change.

Impact on Land

Rising sea levels owing to climate change would force communities in low line coastal areas and river deltas to move to higher ground level. Similarly, increasing frequency of droughts due to climate change would force farmers and pastoralists, who rely on rain fall to raise their crops and livestock, to migrate to areas in search of land and water. This migration/ displacement of people would result in direct conflict and competition between migrants and established communities for access to land and

water. It may be difficult for displaced communities to maintain their farming or pastoral traditions. A broad based policy and program that provides opportunities for the displaced communities to earn livelihood outside the agricultural sector may need to be evolved

Effect on quality

According to the IPCC's TAR, "The importance of climate change impacts on grain and forage quality emerges from new research. For rice, the amylose content of the grain--a major determinant of cooking quality--is increased under elevated CO₂" (Conroy et al., 1994). Cooked rice grain from plants grown in high-CO₂ environments would be firmer than that from today's plants. However, concentrations of iron and zinc, which are important for human nutrition, would be lower (Seneweera and Conroy, 1997). Moreover, the protein content of the grain decreases under combined increases of temperature and CO₂ (Ziska et al., 1997) http://en.wikipedia.org/wiki/Climate_change_and_agriculture_-_cite_note-21 Studies have shown that increases in CO₂ lead to decreased concentrations of micronutrients in crop plants This may have knock-on effects on other parts of ecosystems as herbivores will need to eat more food to gain the same amount of protein (Carlos E. Coviella and John T. Trumble, 1999)

Studies have shown that higher CO₂ levels lead to reduced plant uptake of nitrogen (and a smaller number showing the same for trace elements such as zinc) resulting in crops with lower nutritional value (Scherer, Glenn Grist July, 2005) This would primarily impact on populations in poorer countries less able to compensate by eating more food, more varied diets, or possibly taking supplements.

Erosion and fertility

The warmer atmospheric temperatures observed over the past decades are expected to lead to a more vigorous hydrological cycle, including more extreme rainfall events. Erosion and soil degradation is more likely to occur. Soil fertility would also be affected by global warming. However, because the ratio of carbon to nitrogen is a constant, a doubling of carbon is likely to imply a higher storage of nitrogen

in soils as nitrates, thus providing higher fertilizing elements for plants, providing better yields. The average needs for nitrogen could decrease, and give the opportunity of changing often costly fertilisation strategies.

Potential effects of global climate change on pests, diseases and weeds

Global warming would cause an increase in rainfall in some areas, which would lead to an increase of atmospheric humidity and the duration of the wet seasons. Combined with higher temperatures, these could favor the development of fungal diseases. Similarly, because of higher temperatures and humidity, there could be an increased pressure from insects and disease vectors.

Role of Organic Agriculture

Organic agriculture emits much lower levels of green house gases (GHG), and quickly, affordably and effectively sequesters carbon in the soil; global adoption of organic agriculture would deliver additional emissions reductions of approximately 0.6 to 0.7 Gt CO₂ through the avoidance of biomass burning (CH₄ and NO₂ emissions) and the avoidance of 0.41 Gt CO₂ year emitted from the use of fossil energy consumption for chemical N fertilizer production.

Organic Agriculture minimizes the financial and resource barriers to farming and therefore enhances people's access to local food. Input costs in organic agriculture are much lower as it avoids costly external inputs such as chemical fertilizers, pesticides and fuel. Lower costs reduce financial risk, avoids the need for credit and subsequent indebtedness. As fossil fuel prices rise the cost of external chemical inputs will rise further, making reliance on these inputs increasingly risky. Organic agriculture also reduces risk by increasing the diversity of food and income sources and therefore reduces the risks associated with the failure of a particular crop. The high diversity of organic agriculture leads to greater ecological and economic stability through optimized ecological balance and risk spreading.

In spite of all these potentials the penetration of natural/organic farming is very weak due to the

biased Government extension methods. Absence of credible/accessible certification schemes for organic growers prevents them to compete successfully in export markets. This is primarily due to the fact multinational companies are dictating research priorities in food production / processing etc. and hence, there is low priority for locally relevant /self reliant solutions (Moli, 2010).

Mitigation and Adaptation Measures

- India needs to chart multiple strategies to cope with the impending threats of climate change, which are additional to the existing environmental stresses. This should include i) Research for an improved understanding of climate change – related issues; ii) The adoption of sustainable development pathways ; iii) Increasing the adaptive capacity of the poor; and iv) Working towards a global arrangement to reduce ambitions of green house gases at the earliest.
- The synergy, or trade – off, between addressing climate change and economic development from the long term perspective needs to be understood. India should not focus only on short term financial gain from climate change-related global institutions and mechanisms. The government should treat it as a fundamental problem with potentially serious adverse socio-economic and environmental consequences. It should seek long term solutions to mitigate climate change to reduce its adverse impact on the poor.
- An informed public debate involving all the stakeholders, such as policy makers experts, environmental non-governmental organizations, industry associations, mass medium, farmers and fishermen's representatives, is necessary. The national climate change policy making process should be broad based, given the urgency, scale of impact and differing implications for different stakeholders.
- Developing climate impact modules that give a better understanding of how climate change affect crop, livestock and fish farming and forestry at a local level in order to be well prepared.

- A diversified pattern of livelihoods and adapting agricultural, fishing and forestry practices to efficient water management and soil conservation practices and growing resilient crops at praise.
- While agricultural research Institutes and Universities have already been engaged in researching drought-resistant and saline resistant crop varieties for arid regions and rainfall tolerant and short duration varieties for flood proven regions, Government and private sector will have to invest substantially in agricultural research on one hand and motivate/train farmers to take better advantage of the dry rabi season in the flood proven regions and help them supplement their income through non-farm activities on the other.
- To develop land use plans, food security programs, fisheries and forestry policies that can help farming community suitably adapt to climate changes.
- To undertake cost/benefit analyses of climate changes risks for irrigation or coastal protection and for investment decision.
- Promotion of “best crop-fish farming practices” through farmer’s capacity building and networking. Conceptualization and implementation of “National Adaptation program of Action on climate change”.
- Improve the management of rice paddies production through judicious use of organic manure, fertilizers, irrigation water, nitrification inhibitors, fertilizer placement and their scheduling.
- Improve management of livestock population especially ruminants and its diet. Increase soil organic carbon through minimal tillage and residue management.
- Improve energy use efficiency in agriculture through better designs of machinery and by resource conservation practices.
- Change land use pattern by increasing areas under biofuels, agro-forestry but not at the costs of food production.
- A huge funds are required for adaptation.

A new model of development is required to give urgency to coping with climate change. Funds are required to go in for researching crop varieties that are resistant to drought-heat and floods that sequester more carbon and can make better biofuels. Besides, other sectors too need funds adapt as well.

- Agro-forestry that is cultivation of trees together with crops can help farmers cope with several of the adverse consequences of climatic change. Planting of trees between the crops and in the boundaries around crops can help prevent soil erosion restore soil fertility and provide shade for other crops. The practice of improved fallow also holds great promise. Optimal use of retained rain water through agro-forestry practice could be one of the effective ways of improving adapting capacity of the systems to the climatic changes.

Conclusion

Climate change and agriculture are inseparably linked global scale, both affecting and influencing the other. Food sovereignty is the “right” of peoples to define their own food, agriculture, and livestock and fisheries system, in contrast to having food largely subjected to international market forces. Climate change and global food crisis have put spotlight on the vulnerability, unsustainability and social inequity of agriculture and food production. The challenge for Indian Agriculture is to adopt to potential changes in temperature and precipitation and to extreme events without comprising productivity and food security. The consequences of these changes may result in a need to adopt existing regulations with respect to environmental-policy goals. The government should emphasis on climate change adaptation issues in development strategies and programmes. It is necessary to make sufficient investments to support climate change to adaptation and mitigation, technology development, transfer and dissemination among farmers. Any delay in action to address the climate change will make future actions more expensive and even more difficult to agree upon.

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AGRICULTURAL DEVELOPMENT POLICIES AND PROGRAMMES

Arpita Sharma

The Indian Agriculture is at the cross roads. While demand for commodities is increasing, input prices have increased steeply and there is need to increase productivity. The GDP in agriculture has fallen over the decades even as agriculture supports nearly 70 per cent of the population. The challenge before Indian agriculture is to feed the second most populous nation in the world accounting for about 17 per cent of world's population supported by only 2.4 per cent of the land area.

The demand for food grains in the year 2020 is projected at 255 million tones comprising 112 million tones of rice, 82 million tones of wheat, 39 million tones of coarse cereals and 28 million tones of pulses. Despite the Green revolution, Blue revolution, the White revolution and the Yellow revolution the compound growth rate in agricultural production has stuck at around 2.7

per cent per annum since independence. While agriculture scientists call for the need for a Second Green Revolution, there are novel ways to increase productivity. The Government has initiated various programmes for better agriculture development.

There are several development programmes to promote agriculture and rural sector. The first development programme after independence was the community development programme launched on October 2, 1952. Subsequently large number of programme like Hill Area Development Programme, Desert Development Programme, Drought Prone Area Programmne, Antodaya Programme, Rural Development Programme, National Food Security Yojana, Rastriya Krishi Vikas Yojana, and Food for Work Programme, National Horticulture Mission and Several other programmes has been added. Several projects in the country have had massive funding from external sources. World Bank, Asia



Development Bank, UNICEF, USAID, DFID and Japanese Government are the main sources to finance development programmes in the country. Performance of most of the projects funded by these organizations has so far been very poor. The Indian Council of Agricultural Research [ICAR] successfully completed a World Bank aided 6.5 years National Agricultural Technology Project [NATP] in April 2006. To consolidate the gains under NATP and to address more challenging emerging issues the Government of India [GOI] and the World Bank undertook National Agriculture Innovation Project [NAIP] for a period of 6 years [July 2006 to June 2012] with budget allocation of 250 million dollar. One of the components of NAIP is sustainable Rural Livelihood Security wherein several technologies development under NATP and other paces supposed to be used to address location specific problems in SRLS component of NAIP.

Approaches towards better Agriculture

[1] Canal Irrigation Project [1991]: This project was initiated in 1991. The main objective of this project was to increase irrigated land during a 15 years span [1991-2004] irrigated land has reduced [178 lakh] hectare in 1991-92 lakh hectare in [2003-04] due to poor maintenance, lack of cleanliness and repair work.

[2] MP local area Development Fund [1993]: This programme was initiated for development work in area represented by MP. The scheme did not make any tangible development with several flaws in its execution.

[3] National Agricultural Technology Project [1998]: The National Agricultural Technology Project (NATP) is a dynamic instrument of introducing major changes in the Agricultural Research and Extension systems of the country, besides developing their capabilities to meet future challenges. The project was initiated by Ministry of Agriculture, Govt. of India with the financial assistance of World Bank and would be implemented with the assistance of MANAGE in 28 districts covering 7 states, viz. Andhra Pradesh, Bihar, Jharkhand, Himachal Pradesh, Maharashtra, Orissa and Punjab. Agricultural innovations and diffusion of new technologies are important factors in the country's quest for food,

nutrition, environmental security and enhancement of income and employment.

Agricultural research in India has generated outstanding productivity increases in the past and shall continue to play an important role to support rural livelihoods and accelerating rural growth. However, rising population and per capita income are pushing up the food demand, which needs to be met through enhanced productivity per unit area, input, time and energy. At the same time, issues of decreasing factor productivity and resource use efficiency have emerged. Furthermore, many promising research findings have not reached the producers, due either to the inadequacies of research design or research results, deficiencies of delivery systems or a lack of economic incentives. This is particularly evident in complex environments and in less-favored areas. In order to address poverty and hunger, it is critical to redirect and augment resources devoted to agricultural research to the farming and livelihood systems of the poor rural communities. Further, to avail the technological breakthroughs that are now available for commercial use, agricultural research priorities and strategies will have to be revisited and new system-wide approaches need to be developed and adopted. The NATP will address the above concerns through a combined effort on changing content and process. Policy and technology options will be checked or tested by the end-user for applicability and for economic, social and environmental sustainability. In applied and adaptive research projects, the end-user of innovations will be involved from the start of programmes and projects to their completion. Both indigenous knowledge and new or frontier technologies will be used to generate targeted products. The overall objective of NATP is to facilitate the accelerated and sustainable transformation of Indian agriculture in support of poverty alleviation and income generation through collaborative development and application of agricultural innovations by the public organizations in partnership with farmers groups, the private sector and other stakeholders.

[4] Agricultural Technology Management Agency (ATMA): ATMA is a society of key stakeholders involved in agricultural activities for sustainable

agricultural development in the district. It is a focal point for integrating Research and Extension activities and decentralizing day to day management of the public Agricultural Technology System (ATS). It is a registered society responsible for technology dissemination at the district level. As a society, it would be able to receive and expend project funds, entering into contracts & agreements and maintaining revolving accounts that can be used to collect fees and thereby recovering operating cost.

[5] National Horticulture Mission [2005]:

To promote holistic growth of the horticulture sector through area based regionally differentiated strategies the National Horticulture Mission [NHM] was launched in the country, during the Xth plan with effect from 2005-06.

NHM ensures development of horticulture sector duly ensuring horizontal and vertical linkages with the active participation of all the stake-holders. Under the mission, 352 district in all the States and two Union Territories [Andaman & Nicobar, Island and Lakshawep] are covered except eight North Eastern States, Jammu & Kashmir, Himachal Pradesh and Uttarakhand, which are covered under the technology Mission for Integrated Development of Horticulture in the North Eastern States [TMNE]. The scheme has enhanced horticulture production improved nutritional security and income support to farm households and others: has established convergence and synergy among multiple on-going and planned programmes for horticulture development.

The scheme has also helped in generating employment for skilled and unskilled persons, especially unemployed youth. The mission envisages an end-to end approach covering production, post harvest management, processing and marketing to assure appropriate returns to growers/producers and top double horticulture production by 2011-12 with a production of 300 million tones through a targeted achievement of 6% growth in horticulture. An amount of Rs. 3503.11 crore has been released for implementation of the scheme since its inception till date, against the allocation of Rs. 3880.00 crore. An outlay of Rs. 1100 crore is earmarked for implementation of the scheme during 2009-10.

The salient achievements under the Mission are coverage of an additional area of 12.54 lakh hectares of identified horticulture crops in 87 crop clusters besides rejuvenation of 2.06 lakh hectares of senile plantations, establishment of 1935 nurseries for production of quality planting materials adoption of organic farming in an area of 1.11 lakh hectares besides establishment of 66,019 units of vermicompost units for promotion of organic farming in horticulture, adoption of IPM in an area of 5.73 lakh hectares besides establishment of 294 IPM/INM infrastructure facilities such as Bio-control labs, plant health clinics, leaf tissue analysis labs, disease forecasting units, creation of 13,091 community water tanks. Training of 4.24 lakh farmers with in the concerned states and 57,000 farmers with in the concerned states and 57,000 farmers outside their states through exposure visits and training for enhancing capacity building on horticulture. Assistance has also been provided for establishment of 1109 pack house, 109 cold storages, 23 refer vans besides creation of 35 whole sale markets, 174 rural markets, to help in proper handling and marketing of horticulture produce.

The impact of the mission has been from the positive trends in increasing area under fruits to 4.964 million hectares with a production of 45.29 million tones while the area under vegetables is 6.756 million hectares with a production of 101.43 million tones. India is the second largest producer of fruits and vegetables in the world next to China. The horticulture sector contributes around 28.5 per cent of agriculture.

[6] Support to State Extension Programmes for Extension Reforms [2005]: The scheme was launched in May 2005 with an objective to support state Governments efforts to revitalize their extension system. The scheme promotes decentralized farmers driven and farmer's accountable extension system through a new institutional arrangement for technology dissemination in the form of an Agriculture Technology Management Agency [ATMA] at district level. The funding support to the states is provided on the basis of state Extension work plans [SEWPs], which are prepared through a bottom up planning process starting at the block level and consistent

with training and extension needs emerging from Strategic Research Extension Plans [SREPs].

The activities include up gradation of State Level Extension Training Institutions, HRD of Extension functionaries, agricultural exhibitions/*melas*, agricultural fairs, field days, *Kisan Goshthies*, mobilization of farmers groups, training/exposure visits, field demonstrations, information and dissemination through print and electronic media, setting up of farm schools, farmers-Scientists Interaction, assessments, refinement, validations and adoption of frontline technologies, extension activities through agri-entrepreneurs and PG diploma in Agricultural Extension Management, setting up of community radio stations rewards and incentives. The coverage under the scheme has been progressively increasing-today ATMA's have been established in 586 districts of 29 states and 2 UTs. Total of 7978 farm schools have so far been set up under this scheme. Over 91lakh farmers including 17.97 lakh women farmers have been benefited under the programme. A sum of Rs. 440.99 crore have been released to the States/UTs under this Scheme in the last four years. Changing agriculture in a way that makes it more sustainable is a big challenge.

To create a flourishing sustainable agricultural system that meets the country's needs and those of future generations, the Ministry is working towards evolving innovative Government Policies that are grouped in both the science and economics of agriculture, research to science and economics of agriculture research to develop new technologies as well as extension services to update farmers about new developments that could help them through transitions to sustainable agriculture.

[7] Rastriya Krishi Vikas Yojana [2007]: To provide benefit the farmers community, the Ministry of Agriculture has launched the Rastriya Krishi Vikas Yojana [RKVY] during the financial year 2007-08 to encourage the state to invest more towards agriculture and allied sectors so as achieve 4 per cent annual growth. This would help in increasing the production and productivity. The Ministry has envisaged an outlay of Rs. 25,000/- crore for the 11th Five Year Plan. The scheme requires the states to prepare District and State Agriculture Plans for

creation of such infrastructure, which are essential to catalyze the existing production. The scheme provides adequate flexibility and autonomy to the state Governments in selection, planning and implementation of project under this new flagship scheme. The scheme provides adequate flexibility and autonomy to the state Governments in selection, planning and implementation of project under this new flagship scheme. The scheme provides funds to the state as 100 per cent grants.

Some of the major activities for which the scheme is available are integrated development of food crops, agriculture mechanization, animal husbandry, dairying and Fisheries and development of market infrastructure. The new initiative has elicited an enthusiasm response from the states. Many states have prepared their District Agricultural plan and others are in the process of preparing the same. Funds to the tune of Rs. 4133.69 crore have been released to the States/UTs during 2007-08 and 2008-09 under the scheme. The states have taken up projects relating to minor/micro irrigation, watersheds, strengthening of seed farms, horticulture, setting up of soil/seed/fertilizer testing laboratories, farm mechanization, animal husbandry, dairying and fisheries. Under the scheme an amount of Rs. 4100.00 crore is expected to be released to the State Governments and Union Territory Administrations during 2009-10.

[8] National Food Security Mission [2007]: Understanding the importance of food security the National Development Council in its 53rd meeting held on 29th May, 2007 adopted a resolution to launch Food Security Mission comprising of rice, wheat and pulses to increase the production of rice by 10 million tons, wheat by 8 million tons and pulses by 2 million tons by the end of Eleventh Plan. According to National Food Security Mission has been launched since Rabi 2007 with a financial outlay of Rs. 4882 crore. NFSM is under implementation in 312 district of 14 states;

NFSM is under implementation in 312 district of 17 states viz NFSM wheat in 141 districts of 14 states. It covers about 13 million hectares of wheat, 20 million hectares of rice and 85 per cent of pulses areas. Mission equips the farmers with

improved technologies i.e. seed, micronutrients, soil amendments, farm machinery, Integrated Pest Management and resource conservation technologies, demonstrations and training of farmers on the pattern of farmers; field school along with effective monitoring and better project management.

Some of the major achievements with this scheme have been:- [1] 2.35 lakh demonstrations of improved varieties of rice and wheat, SRI of rice and hybrid rice conducted. [2] 47.83 lakh quintals of high yielding variety/hybrid seed of rice, wheat and pulses distributed. [3] Nearly 12 lakh hectare of area treated with soil ameliorants [Gypsum/Lime/Micronutrients] to restore soil fertility. [4] Nearly 9.7 lakh hectare of farm land treated under Integrated Pest Management. [5] Nearly 4.3 lakh farm implements distributed. [6] Capacity Building of farmers through 14535 farmers field schools. [7] 55,000 farmers have benefited through resource conservation technologies. [8] Production of 77.63 million tonnes of wheat nearly 1.82 tonnes more than 2006-07. [9] Production of 99.37 million tonnes of rice during 2008-09 nearly 2.7 million tonnes more than 2007-08. [10] pulses productivity increased over 2007-08 in NFSM district: TN 19 per cent, Rajasthan 100 per cent, Punjab 18 per cent, Haryana 66 per cent, Andhra Pradesh 20 per cent. [11] Pulses Productivity increased over 2006-07 in NFSM districts: Rajasthan 65 per cent, Punjab 3 per cent, Haryana 0.25 per cent, Andhra Pradesh 30 per cent. **[9] Micro-Irrigation Scheme [2007]:** The main objective of this scheme was to improve water use efficiency through drip and sprinkler irrigation. **[10] National Research Centre for Women in Agriculture (NRCWA):**

The National Research Centre for Women in Agriculture (NRCWA) has been functioning at Bhubaneswar, Orissa, for developing methodologies, for identification of gender implications in farming systems approach and to develop women specific technologies under different production systems. There are 16 ongoing research projects in the areas of gender study on agriculture and household economy, management of coastal agro-eco system, extension methods for

farm women, standardization of women specific field practices, occupational health hazards, reducing drudgery of women in agricultural operations, improvement of farming system suited to farm women, eco-friendly pest management technologies for vegetables among farm women, evaluation of interactive learning modules, technological needs in empowering women in rural aquaculture, and improvement in storage practices of seeds and grains. Under project on Development and testing of extension methods for farmwomen in eastern India, the extent of participation of farm women in different farming systems and farm enterprises and the role of change agents in that context, were studied. Contrary to the situation at coastal tract the male extension agents maintained higher contacts with farmwomen than the lady extension agent.

The studies under *Identification and improvement of farming systems suited to farmwomen in Eastern India* project revealed that there is intense involvement of farmwomen in vegetable cultivation necessitating to take follow up supportive activities and interventions in the area of vermicomposting, natural plant pesticides, biological control and IPM. Under the project *Standardization of women specific field practices in rice in Orissa* data were collected from women heads of 50 farm families on participation of women in relation to varying operations in rice cultivation. Women of family contributed highest hours per season (61.66) in harvesting and post harvesting operations and participated lowest in land preparation. Same pattern was observed from the paid women and total women (family + paid labour). Under project on *Occupational health hazards of farm women in coastal Orissa* the health hazards faced by women in household activities, farm activities, post.

Way forward: [1] National level Task Force:

There should be a national level Task Force to draw guidelines for convergence in planning and implementation at district level in major and flagship programmes of the Central Government like Rashtriya Krishi Vikas Yojana, National Horticulture Mission, Food Security Mission with Mahatma Gandhi National Rural Employment Guarantee Scheme.

The Task Force should ensure that dedicated officials with fixed term of not less than two years of tenure should be entrusted such responsibility with defined objectives. [2] There is need for accelerated emphasis for area expansion and productivity enhancement in horticulture.

Horticulture is the key component to double the agriculture growth from less than 2 per cent in 10th Five-Year Plan to more than 4 per cent in 11th Five-Year Plan.

[3] Extension Services: Promote the establishment of 50,000 village based farm schools throughout the country, mostly as private institutions supported and supervised by government.

[4] KVK: Krishi Vigyan Kendras should work in a holistic approach with agriculture, horticulture and other sister departments in the district for effective delivery of the technology and inputs in an effective way. They should meet every quarter to discuss their input delivery and technology dissemination strategies in an effective manner.

[5] Training institutes: Establish central and satellite farm production training institutes in each state to train and certify farm school instructors. Agricultural graduates and lead farmers to be certified as instructors and offered incentives for establishing private farm schools to train local farmers. Multimedia training materials to be developed for training farm school instructors and for farmer training.

[6] Self Help Group: Promotion of Sustainable Self-Help Groups to adopt farming ventures such as dairy farming, mushroom production, fish production, beekeeping and food processing. These SHGs can also take the task of input delivery among the group members, contract farming and marketing of their produce. **[7] Expert System:** Computerised expert systems should be developed for crop selection, soil nutrition, disease and pest identification and management. **[8]**

[9] Community Radio Station: Community Radio station for agriculture and rural development should be promoted in Public – Private Partnership model. Community radio, Call

centres and Mass media need to be harnessed for wider dissemination of best practices. Village Knowledge Centres, and online databases in local languages should be established. **[10] Farmers Field School:** Farmers Field School should be established at Panchayat level and these Panchayats should be linked to agriculture universities of the region in that state through multimedia to address the queries of the farmers quickly to reduce the crop losses. This model is working successfully in Gujarat which needs replication in other parts of the country. **[11] Development of mandis:** The hi-tech network to provide information on availability and prices of agricultural produces in the mandis should be developed to benefit the farmers

Conclusion: In absence of appropriate rural development policy environment and tardy implementation of land reforms there has been increasing marginalization of land holding and number of landless labored. Lack of micro-level planning, absence of people's participation and uncoordinated efforts by a multiplicity of agencies has not given the expected results. These programme are merely reduced to subsidy giving programme share merely reduced to subsidy giving programmes shorn of any planned approach to the development of the rural poor as an inbuilt process in the development of the area and its resources.

Studies and surveys point out glaring deficiencies in planning, implementation and monitoring, despite programme are conceptually well thought of, establishing lack of concern, commitment and accountability of implementers. Unfortunately achieving targeted physical units and financial expenditure is more important than achieving the ultimate objectives. It is necessary to revisit concept, planning and approach towards rural development programmes.

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MILKING IT RIGHT : THE PROBLEMS AND PROSPECTS OF THE DAIRY SECTOR IN INDIA

Kaberi Bhattacharyya

India is the leading milk producing nation of the world as well as the largest consumer of milk and milk products. Again it has been estimated that the demand for milk and milk products in the country will rise exponentially in the future with steady growth in overall income. Yet the overall development in dairying, especially in view of its multiple economic and social benefits, leaves much to be desired. The country's dairy exports are also insignificant.

This article discusses the prospects of the dairy sector in India, the major problems that inhibit its full-fledged prosperity while briefly highlighting the key areas which call for immediate remedial action.

Milk forms an integral part of the diet of almost all Indian households. Here is an item of food that effortlessly cuts across diversities in age, taste and geographical settlements and finds acceptance beyond the culinary – particularly for religious or medicinal purposes.

Such well-entrenched popularity in the world's second most populous country of ours

naturally generates mind-boggling demand; and it does not come as a surprise either that India is one of the leading milk-producing nations of the world in the current times. Yet the dairy farming households across our country especially at the grassroots level do not always enjoy the prosperity that should be default for such demand intensive sector.



Objective

This article seeks to delve into the problems that underlie the dairy sector in India, given its sustained and growing prospects – and the time-frame that the present paper has generally focused upon is the post-liberalisation period.

Background

In the two decades following Indian independence i.e., in the 1950s and 1960s, milk production in the country was stagnant and the resultant imbalance in the demand-supply of liquid milk for urban consumers was met by importing anhydrous milk fat / butter and dry milk powders. Then in 1970 India's National Dairy Development Board (NDDB) initiated Operation Flood under the stewardship of its then Chairman Verghese Kurien. It sought to increase milk production, augment relevant rural incomes and ensure fair prices for consumers. The programme was enormously successful and it resulted in making India one of the largest producers of milk and milk products, thus christening for itself the 'White Revolution of India'.

Operation Flood was implemented in three phases – its cooperative structure and the creation of a National Milk Grid clearly demonstrating the economic viability of production and distribution of milk and milk products which the farmers could very much carry out on their own – seeking to eliminate the prevalent vice-like grip of middlemen and reducing thereby the seasonal price variations.

Two decades after the initiation of Operation Flood, liberalization of the Indian economy took place in 1991. Here along with several others the dairy sector was also de-licensed. But then the 'Milk and Milk Products Order' (MMPO) came about in 1992, through which dairy processing policy was put in place and some controls were reinforced on the dairy sector like specification of collection areas/milk sheds, fixation of processing capacity and so on. However exactly ten years later in 2002, MMPO was revised

and the said controls were generally withdrawn. But at the same time, the import restrictions to protect domestic dairy market stand undiluted.

Prospects

All these moves have heralded a new era in the dairy sector. The tremendous growth opportunity envisaged through Operation Flood has been explored in the following decades. There have been progressively large public investments in milk processing sector through cooperatives and at the same time private sector investment in dairying has increased considerably. India has gradually emerged as the largest milk producer in the world, churning out about 100 million metric tones of milk in 2004-05 worth Rs. 1179 billion which almost equals the combined output of paddy and wheat.

However, arguably one of the most critical contributions of Operation Flood has been the linking-up of the rural producers with the urban consumers. This has had significant and far-reaching consequences on rural employment, income and therefore rural nutrition, as well as women empowerment. For example, Amul – the dairy cooperative based in Gujarat procures about 12 million litres (peak period) of milk per day from 15,712 village mlk cooperative societies, spanning 17 member unions covering 24 districts, and 3 million milk producer members. (<http://www.amul.com/m/organisation>).

In 2011, Amul paid its farmers approximately Rs 380 for every kg of fat. Therefore for buffalo milk which contains a higher concentration of fat (about 7%) the effective price works out to around Rs 27 a litre – a tardy sum for the impoverished farmer. Alongside, the far-reaching social implications cannot be altogether overlooked. Amul's milk unions in Valsad, Panchmari or even parts of Surat collect almost 80% of their milk from tribal milkmen. These tribals who did not have any exposure to rearing of milch animals, were initiated into scientific dairy farming by Amul. Again, Hatsun Agro Product Ltd procures about 4.5 lakh litres of milk from the Naxalite belts of Dharmapuri and Krishnagiri districts in Tamil

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Nadu. Such winning endeavours paving the way for sustained financial independence of these backward communities could profitably be used to tackle one of the dominant threats to internal law and order situation of present times – the Maoist insurgency, plaguing by and large the poverty-stricken tribal-infested belts of India.

Andhra Tops

Andhra Pradesh tops the list in dairying activity in our country, having experimented with innovative models (a very successful example being Andhra Pradesh Mutually Aided Cooperative Societies Act, 1995^a) and has prominent and intensely competitive players in the private sector. It is noteworthy here that while there are regions spread across the country whose performance in dairying activity is average and above average, it is the eastern states of Orissa, Bihar and North Eastern region who have put up a below average performance. But overall for its pro-poor impact dairying is firmly embedded in the country's farming system. While incomes from regular crop agriculture seek to generate bulk money once or twice a year, it is susceptible to vagaries of crop failure. Quite in contrast the income from dairy-farming is steady even if not overwhelming – but effective nonetheless as a source of liquidity to keep the home-fire burning, thereby being a hedge against the tragic farmer suicides.

Here it may be mentioned that although 60% of our GDP originates in rural areas, only 18% is accounted for by agriculture; and in the context of poverty eradication, as around 70% of India's population live in the rural areas they really cannot be expected to comfortably sustain on just about a fifth of the country's GDP (from agriculture). Again although the growth of agriculture has slowed down considerably (it has not been more than 2% in the past 10 years) livestock sector growth rate is more than 4.5%.

So it is encouraging to note that small and marginal farmers constituting about two thirds of farming households with ownership of only about 33 % of land (less than 1 hectare of land per household), lay claim to about 60% of female cattle and buffaloes and are engaged in milk production. Being less rainfall-dependant, dairying is being increasingly explored as an additional if not crucial avenue of

earning for reasons which are thus not far to seek. It is a livestock enterprise that does not need skilled labour, thus reducing costs and making availability of labour easy and it also entails short gestation period – therefore farmers can engage in dairying with relative ease to improve their livelihoods. Regular milk sales allow them to move from subsistence earning to market-based income. Cattle also serve as an insurance cover for the poor households, being sold during times of distress. Additionally, for the ordinary Indian dairy farmer, cattle-feed is mostly residual from crops and cooperatives also distribute feed at subsidized rates. The cow dung is used as organic fertilizer for crop production apart from being widely used as fuel in rural areas. The gobar gas derived from the dung has its use as domestic fuel; it also helps in running engines to draw water from the well.

Benefits

The healthy impact of a supplementary income notwithstanding, the benefits of dairy farming accrue from a wider perspective too. The strong affinity of Indians for milk is well-known especially in the context of its health connotations. Ingrained into the 'lacto-vegetarian' tradition of our country, it has been the glorious part of diet of sages, holy men from time immemorial and that which almost every mother down the ages, have made it mandatory for her child to drink.

Again for those settled in the Vaishnav –Jain-Arya Samaj belt of Gujarat, Rajasthan, Punjab Haryana, Uttar Pradesh, Madhya Pradesh and Bihar milk forms the principal source of animal protein. And in any case, there will be very few people in our country who would refuse milk or milk-based delicacies in their daily lives or not covet them with a rise in income. It is deemed to be a 'superior' food and the insights gleaned from Engel's Curve in Consumer Economics points out that as incomes rise, people substitute 'inferior food'(for example cereals) with items of superior food.

With growing population and estimated steady increase in GDP at about 6.9% ~ 7%, (<http://ibnlive.in.com/news/full-text-the-economic-survey-201112/239476-7-172.html>) the already mind-boggling demand for milk and dairy products in the

country which is essentially income-elastic is set for a quantum leap in not too distant a future, throwing up enormous opportunities for dairy farmers in India. The interesting point to make here is that the increase in demand will be spread across the board – from high-calorie lassi and rabri to healthy UHT milk and pro-biotics. There has been an increase in health-consciousness among all ages particularly the youth who form a significant majority of the total population at present times. With them especially in the urban areas, having keenly taken to dairy like no other there is no dearth in customized dairy-based items like gelato, low-calorie milk and yoghurts, low-calorie milk-chocolates and so on to especially cater to them. The fast-food chains in the urban areas serving mainly the upwardly mobile set also make profound use of dairy in their cuisine. This only fuels the demand for upper-crust dairy products while the rest – that is the middle-class or even those who escape the clutches of poverty to enter into the middle-income fold, have a penchant for traditional items of dairy. Today the per capita availability of milk and milk products in our country is just 263 grams (against the world average of 279.4 grams) but the demand is set to shoot up in the range of 180 million tonnes to 220 million tonnes by 2020. To successfully meet such colossal requirements, annual growth rate in milk production needs to be accelerated from the present 2.5 % to 5%.

Problems

Ironically however, such stellar prospects of the Indian dairy sector remain under-achieved due to the overabundance of problems, therein.

There has been tremendous rise in milk production in the aftermath of Operation Flood to take care of the gigantic demand base in the country. In 2001 India became the world leader in milk production with a production volume of 84 million metric tons. According to NDDB India continues to be the largest milk producing nation in the world in 2010-11 with close to 17% of global production at estimated 121 million tonnes. Incidentally it is also the world's largest consumer of dairy products, consuming almost 100% of its own produce with about a 50:50 split between the rural and urban areas.

Although credited with such fantastic volumes, the productivity of the Indian cattle is sorely

disappointing. India has about 1/5th of the world's total bovine population which means it has about three times as many dairy animals as the USA. However annual milk yield per dairy animal in India is about 1000 kg per year which is one tenth of that achieved in the USA and about one fifth of the yield of a grass-fed New Zealand dairy cow, not to speak of the world average which works out to 2038 kg a year. The chief reasons for such low productivity may be understood to be the genetic make-up of the milch animals and poor nutrition. Closely associated with this phenomenon is the composition of milch animals in the country at around 45% indigenous cattle, 55 % buffaloes and 10% cross bred cows reflecting the limited success of National Cattle and Buffalo Breeding Programme.

Even the existing milk processing facilities leave much to be desired. They are rather thoroughly lacking in capacity to deal with the enormous milk supply. There is an acute dearth of bulk cooling/chilling centres, involving inordinate delay in transportation thereto and inevitable wastage of this highly perishable item of food in the process. Resultantly, only a very insignificant quantity, about 15% of the total production makes way to the dairy plants of the organised sector and the unorganised sector of milkmen dominate the Indian dairy sector. Vendors in the unorganised sector collect milk from local producers and sell the milk to consumers directly, or indirectly through middlemen in both urban and non-urban areas, thereby handling the bulk of the national milk production. Therefore the sanctity in quality – especially the purity and hygiene, as well as, fairness in the price is more often than not violated. In the organised dairy industry, the cooperative milk processors prevail – seeking to process their largest share of the collected milk as 'liquid milk', while it is quite the reverse for the private dairies whose forte lies in value-added products.

It is therefore not very surprising that India inspite of being the leading milk-producing nation in the world is a minor player in the world market. For things to look up, the treatment of raw milk in terms of its physico-chemical and microbiological attributes needs to be radically improved with a focus on the use of clarification and bactofugation in raw milk processing. Sanitary and phyto- sanitary measures have become mandatory for dairy exports as per WTO requirements. For example directives set by EU on import of milk products

from India necessitates complete mechanization in milking of cattle to prevent contamination and also use of potable water, stainless steel machinery and filtered air for processing milk and dairy products. Minimization of fat/protein losses during processing, extension of shelf-life and adoption of Good Manufacturing Practices (GMP) and HACCP would help the country's milk and milk products conforming to international standards and thus make their exports competitive. The Indian sub-continent and the Gulf countries have been found to be the major export destinations for the Indian dairy products like concentrated or sweetened milk and cream-based products as well as butter/fat-based products with some new items like whey-based products, butter oil, processed and powdered cheese being demanded in the recent past.

Cattle Feed

As has already been mentioned, cattle-feed is generally residual and poor quality nutrition has been identified as one of the key reasons for the unimpressive milk-productivity of Indian cattle. Availability, quality and cost of feed are crucial issues for the ordinary Indian dairy farmer and poor feeding practices do not enable them to capitalize on the milk-producing potential of their herd. Land is mostly rain-fed or dry so that the output of dry fodder tends to be low. The availability of land for growing fodder grass is also quite restricted. Here it may be mentioned that although subsidized feed is available through co-operatives but then also it is not always affordable by the dairy farmer.

Another factor which has contributed to the low milk-productivity of the Indian cattle is the erratic availability of veterinary services across the country. There is a focused need for preventive animal health care (specifically addressing foot-and-mouth disease and haemorrhagic septicaemia) and the relevant service providers are State veterinary departments, co-operatives, NGOs, private veterinarians and paravets. While there is almost adequate coverage of such services in the milk-surplus states of Uttar Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu their sparse coverage in the other states has accompanying drawbacks.

But probably at the core of such under-productivity lies the most agonizing problem that

the ordinary Indian dairy farmer has to deal with in his every day life – which is the meagre remunerative aspect of dairy farming. Although the benchmark in pricing is set by cooperatives, the farmers in most of the cases have to negotiate with the middlemen in the unorganized sector to get their daily due. More often than not, they take loan from these middlemen to meet the expenses of their home and hearth and this naturally stems their bargaining power even further embroiling them in the menacing web of punishing interest rates. While premium is paid on fat content and thus quite naturally buffalo milk fetches higher price, the price of cow milk is based on total solids. And at the absence of testing facilities at the village level to fairly judge the solid content in milk, the transparency in pricing cannot really be established.

Cost of Production

Again the cost of production of milk is high due to low annual milk yields, high labour input per litre produced and poor breeding performance. Added to that the rural landless farmer has to buy feed for his cattle which compounds his woes further. Hence the paltry income hardly goes to cover the farm cash costs and contributes very little to the household earnings, barring in the urban areas where the relatively high milk price seeks to set off the additional costs. In spite of such hardships the rural landless farmer engages in dairying – mainly because he may possess surplus livestock – producing milk primarily for home consumption by converting practically free feedstuffs into milk, for getting precious fuel (cowdung) and also to provide the female members of the family with an income-generating activity. However the rural dairy farmer is also wholly aware of the risks involved in depending on dairying for sustenance that of not having an animal in milk in any one year, the death of a lactating animal etc. Happening of any of these events has the potential to slash the puny household income by almost half or even more, and would probably force the family to abandon the dairy enterprise, altogether. Maybe because of such reasons a farmer usually is not too keen on dairy activity when the going is good from agriculture.

The appraisal of NDDDB's actions over the years also reveal that it has also not been pro-active in

promoting dairying at the grass-roots level. That dairying is economically sustaining has already been discussed earlier in this essay – it can be quite life-altering for the humble Indian farmer. Yet in 2009-10, NDDDB procured a mere 8.4% [258.65 lakh kg per day (lkpd)] of the country's production of 112.54 metric tonnes through cooperative dairies and about 70% of such procurement has been made from Gujarat, Karnataka, Maharashtra and Tamil Nadu (who together account for less than 25% of the country's total output). On the other hand, states like Punjab, Haryana, Rajasthan, Bihar and West Bengal who put together more than half of the country's total milk output contributed no more than 20% to the total cooperative procurement. Paradoxically therefore, such skewed development in dairying across the country is leading farmers in one region to take their cattle to slaughter houses in the absence of remunerative returns from dairying while in other regions the same milking units are being burdened to generate unreasonable amounts to meet the escalating demands in dairy products with augmentation of overall income. This situation may also be directly blamed for the spiraling inflation in milk and milk products.

Remedies

Therefore there has emerged a pressing need to adopt a whole new perspective for the dairy sector and imbibe a new lease of life therein especially in the context of its positive ramifications across the economy and society.

- While the cooperative procurement net should be cast far and wide, it is imperative that the productivity of the milch animals be raised

through improved breeding services seeking to upgrade their genetic potential. Making available better feeding options, so that the animals produce milk commensurate to their genetic potential is no less vital.

- In line with such needs, the National Dairy Plan (NDP) – which is a scientifically based multi-state initiative has been launched by NDDDB with a 15 year time horizon. At the ground level the project will be carried out by End Implementing Agencies (EIAs), which includes State Cooperative Dairy Federations; District Cooperative Milk Producers' Unions; Producer Companies and State Livestock Development Boards. In the very first phase which spans six years and involves an investment of around Rs 2,000 crore, attention is sought to be focused on immediate needs like developing high genetic merit bulls to strengthening village-based milk procurement and making the entire process of milk-processing transparent. Funding possibilities for the said project are being explored with International Finance Corporation. The latter needs to be accorded immense and critical significance for its profound economic and social implications; adequate testing facilities at the village level is the first step to ensure justifiable pricing and therefore fair and equitable returns to the vulnerable dairy farmer at the grassroots level – drawing many to this productive engagement and with the capacity to quell many undesirable social developments which tend to spring up in impecunious and socially ostracised regions.



Kurukshetra

FORTHCOMING ISSUES

Self Help Groups	- July 2013
Empowering Rural Women	- August 2013
Rural Education & sustainable development	- September 2013

- Apart from such pan-Indian moves, another alternative to uplift the highly potential dairy sector is the replication of the exceedingly successful 'Amul' model in the rest of the country, with variations to suit the peculiarities in different states and NDDB acting as the lead agency.
- At the same time, overall efficiencies need to be cultivated to perk up yields and minimize wastes and production costs. While state-of-the-art technology in packaging can help retain nutritive value as well as the taste of the dairy and dairy-based products and go to extend their shelf-life, simultaneously cold chains need to be strengthened for appropriate storage during processing and transportation stage.
- Moreover institutional credit at market interest rates must be made available to the poor hapless dairy farmer. As has already been mentioned, it is his prevalent practice to take loan from the middlemen in his business, which inevitably accompanies crippling interest rates and robs him off of his already lopsided bargaining power. Loan from banks with refinance facility from NABARD is available for starting dairy farming

but this piece of knowledge hardly filters down to those who would find it gainful to act on it.

Conclusive Remarks

In the light of rising incomes and the strong affinity that our countrymen share towards milk and milk products, dairying as an economic activity has enormous potential in India – especially in its capacity to bring about decisive changes in the rural economy. Concerted efforts need to be put in from the apex level to remove the deterrents that limit the exploration of the unending possibilities of the dairy sector in the domestic front as well through exports. The new wave of health-consciousness and scientific breakthroughs on the beneficial properties of milk as well as dietary innovations to suit contemporary taste and lifestyles catalyse such sky-rocketing potential. So 'Doing Well by Doing Good' – the core value of a leading FMCG multinational finds absolute pertinence in its application in the Indian dairy sector in the present times.

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GUAR: KITCHEN TO INDUSTRY

Dr Ramesh Chandra Parida and Dr Pranab Kumar Ghosh

Now-a-days, guar has gained importance as an industrial crop as the gum extracted from its seeds has found application in a number of industries, especially in oil and gas industries to stabilize drilling mud.

Since time immemorial the tender fruit of guar (*Cyanopsis tetragonoloba*), popularly known as cluster beans, has been in use as a vegetable in our country, particularly in Northern India. Besides, the plant has been serving as a forage and a green manure. However, now-a-days, it has gained importance as an industrial crop as the gum (a galactomannan polysachharide) extracted from its seeds has found application in a number of industries, especially in oil and gas industries to stabilize drilling mud.

India is the largest global producer of guar accounting for 70 to 80% of it, which is followed by Pakistan. The other countries producing it, are the United States, Australia, Brazil and South Africa.

Guar is a papilionaceous herb growing erect upto 2 meters. The fruits appear in clusters as slender, flat and pointed pods, each pod containing about 10 seeds. The crop matures in 3 to 5 months. The seed yield is about 900kg/ha for un-irrigated land, while it is as high as 1900kg/ha for irrigated land. The crop

is drought tolerant, moderately saline tolerant and grows best in semi-arid regions. Therefore, Rajasthan alone produces about 80% of our global share of guar and states like Gujrat, Haryana, Punjab, Uttar Pradesh and Madhya Pradesh make up the rest. The nutritive value of this vegetable is as follows:

Nutritive value of cluster bean

Sl. No.	Name of the food stuff	Value per 100 gms of edible portion
1	Moisture(g)	81.0
2	Protein(g)	3.2
3	Fat(g)	0.4
4	Minerals(g)	1.4
5	Crude fibre(g)	3.2
6	Carbohydrate(g)	10.8
7	Energy (Kcal.)	16.0
8	Calcium(mg.)	130.0
9	Phosphorous(mg.)	57.0
10	Iron(mg.)	1.08

Considered as a lowly vegetable, guar shot into fame in the world market, when some US based companies like Halliburton, Gazprom, Schlumberger, Ruhrgas and Baker Hughes began to buy the gum prepared from its seeds. These companies help firms to drill wells for petroleum, natural gas and particularly, shale gas by using a pressure – pumping technique known as fracking, which blasts water mixed with sand and chemicals underground to free trapped hydrocarbons from shale formations. A thick gel is prepared from guar seeds and is used to carry sand down to a well and to the cracks created from fracturing.

India annually produces nearly 20 million tones of guar seeds from which 6 lakh tones of gum or gel can be extracted. Since the demand continued to rise in the last few years, its price also kept on increasing peaking at \$ 2,400 per ton of gum in May-June 2011. Therefore, guar acquired the status, of an important



cash crop in our country, particularly in Rajasthan, attracting many farmers to cultivate it. However, recently the drilling firms in USA have started looking for alternative sealants like carbon methyl cellulose



Plant of Cluster bean

and xanthane gum, replacing a natural product by the so - called cheaper synthetic chemicals. As a result, a 40% drop in the export of guar seeds by the middle of 2013 has been predicted.

However, contrary to expectations, the prices of guar seeds and guar gum have shown an upward trend reaching Rs 14,000/quintal and Rs 40,000/quintal in the last few months in the domestic market. There is expectation in some quarters that soon the gum price may reach Rs 1 lakh - a quintal mark. But for such rise in price in absence of a marketing rise in demand from the US and that too when there is a bumper harvest of 18 lakh tones of guar, is due to illegal trading to hold the stock in anticipation of a rising demand in future. The industry officials warn that such artificial rise in price may be harmful to the farmers.

Of course, such fluctuation in demand has caused concern among our farmers, growing the legume. But the situation can be taken care by finding alternative industrial uses for guar seeds and its gum. For example, these seeds can also be used in textile industry to keep the yarn smooth and strong, in paper industry to increase the strength of the paper, in food industry to enhance the taste and texture of various products like ice-cream, desserts, yoghurt, soft bread, pasta, sausages, patties etc and in pharmaceutical industry to make creams and other cosmetics. Guar gum is a food emulsifier, thickener and stabilizer, which can be preferred



Guar Gum

over its synthetic counterparts on health and environmental grounds. The health conscious middle class will not mind to throw a few more coins to buy cosmetics and food with such a natural ingredient. Therefore, these small-scale industries should be encouraged to expand. As a result, not only the nutritive legume will play a significant role in fighting malnutrition, but also, in gainful utilization of our human resources in labour intensive agriculture and small scale industries, ensuring inclusive economic growth of our country. Again, the plants as well as the seeds after the extraction of gum, can be used as cattle feed. Moreover, as the crop is drought and saline resistant and grows well in semi-arid regions, where many others fail, it can pave the way to enhance land utilization.

Shale gas is also present in abundance in our country. A recent survey indicated that only the Krishna-Godavari basin itself holds an estimated deposit of 600 to 2000 trillion cubic meters of it, which can provide us energy for the next 200 years. Besides, the Cambay basin, the Assam-Arakan basin, the Damodar valley and the Cauvery basin also have huge deposits of it. Therefore, when we start drilling those, guar gum can be used there, which is more eco-friendly.

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MILK AND SOY MILK : A COMPLEMENT TO EACH OTHER

Aparna, Purva Jaggi & Sat Pal Saini

Milk is considered complete diet as it contains all the nutrients essential for body. But now a days problems like lactose intolerance, milk allergy, galactosemia, hypertension etc. are there where milk is not medically advisable. An alternative source of proteins and other nutrients is a must in such patients. Soy milk is being considered a good option for this purpose. But composition and nutritional value of soy milk is still not a very commonly known fact. Here are some facts regarding the nutritional benefits of both.

Milk is a white liquid produced by the mammary glands of mammals. It is the primary source of nutrition for young mammals before they are able to digest other types of food. Early-lactation milk contains colostrum, which carries the mother's antibodies to the baby and can reduce the risk of many diseases in the baby. It also contains following nutrients:

Constituents	Quantity
Water	87.8g
Protein	3.2g
Fat	3.9g
----Saturated fatty acids	2.4g
----Monounsaturated fatty acids	1.1g
----Polyunsaturated fatty acids	0.1g
Carbohydrate	4.8g
Cholesterol	14mg
Calcium	120mg
Energy	66kcal

Soy milk Soy Juice (also called soya milk, soymilk, soybean milk, or soy milk and sometimes referred to as soy drink/beverage) is a beverage made from soybeans. A traditional staple of Asian cuisine, it is a stable emulsion of oil, water, and protein. It is produced by soaking dry soybeans and grinding them with water.



Composition of soy Milk : Soy milk contains about the same proportion of protein as cow's milk: around 3.5%; fat, 2.9% carbohydrate, and 0.5% ash. Soy milk can be made at home with traditional kitchen tools or with a soy milk machine.

Preparation of Soy Milk : Soy milk can be made from whole soybeans or full-fat soy flour. The dry beans are soaked in water overnight for a minimum of 3 hours or more depending on the temperature of the water. The rehydrated beans then undergo wet grinding with enough water to give the desired solids content to the final product. The ratio of water to beans on a weight basis should be about 10:1. The resulting slurry or purée is brought to a boil in order to improve its nutritional value by heat inactivating soybean trypsin inhibitor, improve its flavor and to sterilize the product. Heating at or near the boiling point is continued for a period of time, 15–20 minutes, followed by the removal of an insoluble residue (soy pulp fiber or *okara*) by filtration. Plain soy milk is unsweetened, although some soy milk products are sweetened. Salted soy milk is also consumed. The coagulated protein from soy milk can be made into tofu, just as dairy milk can be made into cheese. Most of the soy milk available in the market is flavoured. The most popular flavours are vanilla and chocolate. Some producers add thickeners to their soy milk to give it a mouth feel of cow's milk.

Nutritional values of soy milk

Plain soy milk is very nutritive: it's an excellent source of high quality proteins, isoflavones and B-vitamins. Soymilk naturally contains isoflavones, plant chemicals that help lower LDL ("bad" cholesterol) Soy milk is free of the milk sugar (lactose) and is a good choice for people who are lactose intolerant. Also, it is a good alternative to those who are allergic to the proteins of cow's milk. Soymilk is not a rich source of calcium, this is why most commercial soymilk products are fortified with calcium.

Soymilk naturally contains isoflavones, plant chemicals that help lower LDL ("bad" cholesterol)

One cup of *unfortified* soymilk contains almost 7 grams of protein, 4 grams of carbohydrate, 4½ grams of fat, and no cholesterol. Although soymilk supplies some B vitamins, it's not a good source of B₁₂, nor does it provide a significant amount of calcium. Since many people substitute soy beverages for cow's milk, manufacturers offer *fortified* versions. These varieties may include calcium and vitamins E, B₁₂ and D, among other nutrients.

Nutrition

This chart shows nutrients count in 250ml of plain soymilk.

Nutrient	Soymilk
Calories (gm)	140
Protein (gm)	10.0
Fat (gm)	4.0
Carbohydrate (gm)	14.0
Sodium (mg)	120.0
Iron (mg)	1.8
Riboflavin (mg)	0.1
Calcium (mg)	80.0

Soy Milk V/S Regular Milk

- Cow's milk contains, on average, 3.4% protein, 3.6% fat, and 4.6% lactose, 0.7% minerals and supplies 66 kcal of energy per 100 grams.
- The major difference between soymilk and "regular" milk (predominantly cow's/ buffaloes' milk is that one is derived from a plant and the other from an animal. As with all other animal-based foods, it's a complete protein; that is, it supplies people with all the necessary amino acids to form proteins. Cow's milk contains 8 grams of protein and 12 grams of carbohydrates per cup (225 ml approximately). Cow's milk is a rich source of other nutrients as well. One cup provides adults with about 30 percent of their daily calcium needs and about 50

percent of their vitamin B₁₂ and riboflavin requirements. Often, milk is fortified with vitamin D to facilitate the absorption of calcium. Vitamin A is usually added to milk as well. Depending on the selection, cow's milk can have a significant amount of fat.

- Soy milk contains only vegetable proteins. Vegetable proteins have the advantage that they cause less loss of calcium through the kidneys. It is known that a diet rich in animal (and dairy protein) creates a higher risk for osteoporosis.
- Lactose, the primary carbohydrate in cow's milk, poses a digestive problem for some people. These individuals are deficient in the lactase enzyme that's needed to break down this milk sugar, causing gas, bloating, and diarrhea after consuming some forms of dairy products. Soy milk contains no lactose. As an additional benefit, soy milk contains sugars stachyose and raffinose. These sugars boost immunity and help decrease toxic substances in the body.
- Fewer people are allergic to soy milk: Only 0.5 percent of the children are allergic to soy milk, whereas 2.5 percent is allergic to cow's milk.
- Cow's milk contains naturally occurring hormones: estrogen and progesterone. But soy milk contains no hormones.
- Soy milk does not cause insulin dependent diabetes.
- Soy milk is rich in isoflavones: The presence of isoflavones is the most important and unique benefit of soy milk. Each cup of soy milk contains about 20 mg isoflavones (mainly genistein and daidzein). Cow's milk does not contain isoflavones. Isoflavones have many health benefits including reduction of cholesterol, easing of menopause symptoms, prevention of osteoporosis and reduction of risk for certain cancers (prostate cancer

Soy milk contains only vegetable proteins. Vegetable proteins have the advantage that they cause less loss of calcium through the kidneys. It is known that a diet rich in animal (and dairy protein) creates a higher risk for osteoporosis.



and breast cancer). Isoflavones are also antioxidants which protect our cells and DNA against oxidation.

- Soy milk has little saturated fat and no cholesterol. Unlike cow's milk, soy milk is naturally low in fat. Regular-fat soy milk is naturally free from saturated fat (which is considered to be healthier than unsaturated fat).
- Soy milk is made from plant material instead of an animal byproduct. Therefore it contains no cholesterol. Dairy milk contains about 20 milligrams of cholesterol per cup.
- As it doesn't contain galactose, Soy milk can safely replace breast milk in children with Galactosemia.
- Soy milk lacks casein and is a good source of lecithin and vitamin E.
- Soy milk is safe for people with lactose intolerance, or milk allergy.
- It also helps in fighting the symptoms of menopause and in promoting eye health.
- So Soy milk is not a replacement to regular milk except some special conditions but both are complementary to each other.

[The authors are from Krishi Vigyan Kendra Roopnagar]

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