However, sustainable livestock production is contingent upon optimum utilization of available fodder resources and giving due importance to the quality of crop by-products in the R&D planning. In the Green Revolution era, the introduction of high yielding varieties (HYVs) of foodgrains distorted the grain-straw ratio in favour of grains, and straw of foodgrain crops – which is used as livestock fodder – received least attention in the process of varietal development. This led to shortage of feed and fodder. Presently, out of 55 resource development regions in India, 43 are fodder-deficit. It is paradoxical that more than 5 million tonnes of paddy straw (and some quantity of wheat straw) are destroyed by burning in the fields of Punjab which is a fodder-surplus region. Seasonal and spatial variation (up to 150%, as observed during discussions with the farmers) in fodder prices adds another dimension to this problem. Feeding livestock without chaffing the fodder results in about 50% fodder going waste. Effective institutional arrangements for use of available technologies would be useful to address fodder shortages in deficit marginal environments, thereby addressing the distressing problem of malnutrition among the poor population.

First, scientific ways of fodder conservation could be effective for augmenting fodder availability. Silage making (cost Rs 29.5 per tonne), fortification of dry roughages with urea (4% urea + 40% moisture) and compound feed mixture (50–60% straw + 35–40% leguminous fodder/tree leaves + 10–15% molasses), which can be densified to the extent of 350–400 kg/cubic m, are some of the techniques which add to the digestibility of roughages and require little storage space for fodder resources. Also, probiotics (microbial feed additives) improves the feed utilization capability of animals, thereby enhancing milk production and live body weight of animals. Therefore, scientifically formulated compound feed with selected and high-quality ingredients can help in mitigating fodder shortages during the lean season and increasing livestock productivity. The compound and compacted feed mixture is not only economical, but also requires less (6–7 times) space for storage and transportation. Location-specific institutional mechanisms for maintaining buffer stock (fodder bank) of compact fodder and bulk fodder purchase from surplus regions during peak production seasons should be established in fodder-deficit regions. The Government should play a facilitating role only in the establishment of such institutions.

Second, R&D focus in foodgrain crops is presently biased towards grain yield, paying little attention towards the fodder–grain ratio and quality of fodder. This often leads to non-adoption of even HYVs of food crops. For example, the high-yielding hybrid of pearl millet could not fully succeed in the dry regions of western India, where a locally adapted and highly succulent variety ('Sulkania') of pearl millet performed better in terms of its on-farm economic use. Similarly, presence of spikes in the straw of a wheat variety (Kundan) and prickly thorns on sugarcane leaves (CoJ 67 variety) affects their intake by animals. Therefore, incremental research resources should be allocated for developing nutritious, high-yielding and short duration varieties of fodder crops and HYVs of foodgrain crops, which provide higher grain and straw yield along with good-quality straw.

Finally, food security in itself does not translate into nutritional security. Sustainable livestock production in marginal environments is crucial for improving access to animal proteins and enhancing nutritional security for the poor. Therefore, efforts should be made for creating enabling institutional environments for wider adoption of scientific techniques for conservation of feed and fodder, and maintenance of buffer stock of compacted feed and fodder at local level. Local governance institutions or panchayats can play a significant role in this. It would also make a significant difference in ensuring reliable fodder supply for sustaining livestock whose output will in turn provide nutritional security to the poor and underprivileged population in marginal and fragile production environments.

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Conservation of endangered flora and fauna of Chilika Lake

The Chilika Lake on the Orissa coast is a natural brackish-water lagoon of marine origin bounded by lat. 19°28′–19°54′N and long. 85°05′–85°38′E, and has been designated as a Ramsar site since 1981. The water spread area of the lagoon varies from 1165 sq. km during monsoon to about 906 sq. km during pre-monsoon. It is a pear-shaped, semi-enclosed piece of pristine nature formed by a recurved barrier spit on a gently sloping coast. The lake provides livelihood to nearly two lakh people living in the vicinity.

The Chilika Lake is presently showing symptoms of environmental degradation. A constant inflow of silt amounting approximately to 13 million tonnes per year, due to soil erosion in the catchment area, is choking the mouth of the lake. Satellite images reveal that a 46 sq. km area has been silted up and this area is now infested with weeds and grasses. Another major cause of sedimentation of the lake is the macrophyte growth and its decay. The shrinkage has been calculated at 1.5 sq. km per year. Due to the decrease in salinity and excess nutrients from the silt, weeds have spread over approximately a quarter of the lake. Also, the lake has become an infinite and convenient receptacle for the waste generated by the growing population and the effluent industrial waste discharged into it.

The Chilika Lake also supports a large variety of microalgae, marine seaweeds, sea grasses, fishes and crabs that thrive in its brackish water. The value of marine algae as food and feed depends on their mineral contents. Agar yield in the Chilika Lake will be of special interest because of the occurrence of valuable agarophytes like *Gracillaria verrucosa*, *G. crassa* and *G. edulis*. Utilization of seaweeds would be worthwhile since they contain minerals, trace elements and vitamins. Some brown seaweeds afford scope for the production of algin, mannitol and iodine. Iodine is present in varied quantities in Sargassum and other seaweeds.

The Chilika Lake harbours over 150 migratory and resident species of birds and 225 species of fish, including Irrawady dolphin (*Coryphaena* sp.) and sea cow (*Dugong dugong*). The grassy expanse of Nalabana Island having an area of around 37 sq. km which has been declared a bird sanctuary, is the major refuge of millions of migratory birds. This scenario has been changing day by day. The avain grandeur and fish population are observed to be dwindling rapidly. The Chilika is an attractive lake with splendid avifauna. At the same time it also attracts thousands of people who are eager to exploit it for commercial purposes, such as prawn farming or fishing and thereby cutting and shredding of the waters into small sections. Swathes from Chilika's main body are lost every year from the shores. Unregulated tourism is another factor endangering the Chilika's fragile ecosystem. While birds face problems of poaching, the dolphin is injured and threatened due to the increasing number of motor launches. At present natural resources such as forest and freshwater resources are exploited by the local communities and the lake is therefore under tremendous pressure.

A new artificial mouth was dredged in the year 2000 by the Chilika Development Authority at Magarmukh to reduce the length of the inlet channel by 18 km for salinity restoration and this has brought a new lease of life to the lagoon. After its opening, there is a marked improvement in the exchange of water between the sea and the lagoon, facilitating auto-recruitment and free breeding migration of fish, prawn and juvenile crab into the lagoon, leading to a significant improvement of the fishery resources. The other components of the restoration plan include integrated watershed management with community participation, monitoring and assessment, improvement of socio-economic conditions of the local communities, shared decision making, improvement of communication network, fish stock enhancement, development of a visitor centre, wetland research and training centre, etc.

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Manual drawing of groundwater from borewell/tubewell

Abstraction of groundwater from borewells and tubewells is generally done through pump sets. Many a time, the cost of pump sets with pipes and overhead tank exceeds that of construction of a borewell. During a recent hydrogeological investigation in and around Chelakkara area, Trichur District, Kerala, a unique method of drawing water from a borewell was observed. On enquiry, it was found that the people have been using this system over the last two years, and it was providing trouble-free service. Similar to the bucket and rope method used to draw water, there was no maintenance cost and this system could be operated by anybody without technical knowhow. This technique is used to draw water from borewells, where the depth to water level is up to 15 m below ground level (m bgl). Since it is cost-effective, simple and unique, the technique can be practised in rural and urban areas for drawing water from borewells/tubewells. This method can be used as an alternative to pumps/hand pumps.

The device is similar to bucket and rope method used to draw water from open wells. It is lowered through a pulley hung on the wall/roof exactly above and at the centre of the borewell. A piece of PVC pipe has been modified to draw water in place of the bucket. The borewell, where this method has been adopted has a diameter of 6.5″ and the water level varies between 9 and 14 m bgl. A PVC pipe of 4.5″ dia and 1.3 m length has been used for drawing water. It is sealed at the top with a small hole and a hook to tie the rope. Along the bottom, a reducer is fixed and a small foot valve of 1.5–2″ dia is attached. A special provision is made in the foot valve bottom with a long bolt, which protrudes out of the foot valve (Figure 1 *a* and *b*). When this bolt is pushed inside, it opens the valve inside the foot valve (Figure 1 *c*).

This modified PVC pipe is lowered into the borewell using a rope and pulley (Figure 2). When it touches the water level, the foot valve opens and water enters into the pipe. Then the entire system is immersed into the water column and the PVC pipe is filled up with water. When it is lifted up using the rope and pulley, the valve inside the foot valve

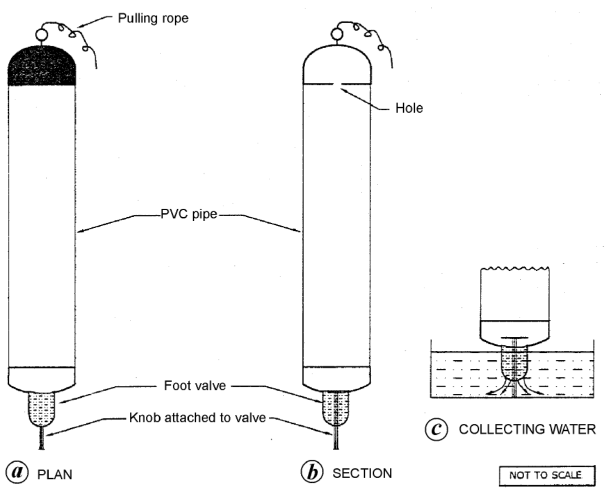

Figure 1. Schematic diagram of manual abstraction method.