CHAPTER 7

SUMMARY AND CONCLUSIONS

7.0 INTRODUCTION:

Agriculture is one of the dominant sector in India. After Green-revolution, this sector was seriously influenced by modern agricultural technology, such as farm machinery, HYV seeds, fertilizers, and pesticides. These transitional changes in agriculture led to more demand for energy. At the same time pressure on irrigation sources has increased to alarger extent due to unfavourable rainfall conditions. Due to this the area under ground water irrigation is increasing at faster rate, which demands large amount of energy sources in Indian agriculture.

It has been identified in several studies that, about 10 percent of energy sources are consumed by agriculture sector. But the energy consumption in agriculture sector in India must be around 15 to 20 percent, which may further increase in near future. On these issues the present chapter highlights the major conclusions drawn from the existing study.

There are several factors that influence the growth performance in Indian agriculture across the states. This can be traced out especially, from Green Revolution in Indian Agriculture. Because Green Revolution it self will demand larger amount of inputs in production process. But all the states which
have been existing are not in a position to provide all the factors at larger extent. Due to this reason the disparities are over veiling in different states.

Irrigation is one of the important device in modern agriculture, where the HYVs seeds when implemented, will demand much amount of water resources. In recent years, the irrigation is affected due to unfavorable rainfall conditions. The area under irrigation is changing continuously over a period of time.

The area under canals has been slightly declining, where as the area under tube wells and other wells were increasing drastically. This is a clear indication that, the pressure on Energy sources such as Diesel and Electricity is increasing at faster rate. This is one of the important highlighting feature of Indian irrigation system and Indian agriculture environment. Due to this, the demand for energy is increasing continuously over a period of time especially from 1966 on wards, when the Green Revolution Programme was implemented in Indian agriculture. At the same time the area under rain fed was fluctuating, due to unfavorable rainfall conditions.

Here the interesting feature is that, sugarcane demands higher rate of fertilizers, as comparing with other crops, next comes to yield per hectare, real cost of production, rate of profit, average net income, labour absorption, and irrigation in sugarcane. On the other hand jowar consumes, low rate of fertilizers, yield, real cost of production, rate of profit, average net income, labour employment, and irrigation. It was
observed that labour employment can be improved by cultivating more of sugar cane. And the state scenario is showing that, for farmers point of view sugar cane cultivation is more profitable, next to cotton, rice, and jowar respectively.

In all most all the states, sugarcane is showing higher cost of cultivation compared with other crops, due to high application of inputs with more operational activities. However, with respect to employment, irrigation, and average net income is also very high in case of sugar cane. But at this stage even though sugar cane is much profitable than that of other crops, one should be aware of the availability of water resources, and other input equipment. For that alternative crops should be recommended in order to remove shortage in inputs and avoiding over water use, which is scarce resource in recent years in Indian agriculture.

7.1 CROPPING PATTERN AND CROPPING INTENSITY:

Due to changes in institutional set up in Indian agriculture i.e the changing of traditional agriculture to modern agriculture, the cropping pattern is changing over a period of time. Incidentally in early years, the farmer concentrated on subsistence crops, and later he diverted towards commercial crops, where commercial crops are more profitable than food crops. Because of this problem India still facing food scarcity, even though she is treated as agriculturally self sufficient. Changes in cropping pattern laid foundation to the several controversial problems such as resource crunch and input scarcity in Indian agriculture.
The whole scenario is shows that, the area under rice and jowar slowly declining, where as the area under wheat and sugar cane increasing at faster rate. However, cotton and ground nut showed fluctuations over a period of time, with changing shares in overall agricultural production.

There are several factors which influencing yield mechanism in Indian agriculture. Generally the yield component was influenced by several factors such as availability of water, fertilizers, energy and other inputs, especially application of inputs at efficient level, which talks about the farm management skills in production.

In general it was observed that the traditional input accounted for the bulk of total factor inputs during the pre-green revolution period while in the subsequent period (green revolution and post green revolution periods) the share of modern inputs has considerably increased. Due to green revolution the output growth has considerably increased in all most all the states. Undoubtedly, considerable growth has occurred in modern inputs during the post-green revolution period but productivity has also fallen steeply amongst the states. The states which has better resource endowments has realised the benefit of technological change in Indian agriculture.

7. 2 FACTOR SHARES IN INDIAN AGRICULTURE:

Draught power still is main source of energy in Indian
agriculture, due to its reasonable and most convenient source for small and marginal farmers. But most of the studies observe that, the maintenance of draught power is very much expensive than other sources. That's why the depletion of animal power took place especially in recent years, from Green revolution onwards. Here the interesting feature is that, animal feed (food energy) is much expensive as comparing with output energy produced by animal.

Indian agricultural production has experienced highly cost intensive during last three decades. The reason for this is that all most all the prices of agricultural inputs and allied equipment have increased drastically due to several reasons. Petroleum based inputs such as diesel, petrol, fertilizers, pesticides, and other lubricants prices gone up especially from 1973 onwards, where there was great oil price hick in world scenario. On the other hand agricultural machinery and implements prices raised at a faster rate while comparing with agriculture production.

The general observation is that prices of inputs increased at faster rate as comparing with prices of agricultural products. On the other side it was highlighted that energy input prices raised at faster rate than energy output prices (food price), due to this reason lot of changes took place in Indian agriculture especially since Green revolution.

7.3 MECHANIZATION IN INDIAN AGRICULTURE:

Farm mechanization is the main plank of modern agriculture
and many of the progressive countries have already mechanized their agriculture. Of course, it is also true that the conditions in many of these countries were favorable for mechanization. Most important conditions for use of agriculture implements and machinery were high rate of agriculture labour, large size of farms, high cropping intensity, higher percentage of irrigated area and more adoption of high yielding technology.

As cultivable land resources are limited, increased agricultural production can only be attained in most countries of the world through increased yields per unit area of land and improved preservation of already produced commodities. Technological inputs must be applied wisely, to economically bring about the desired increased outputs of production. Mechanization is one of the critical inputs of production and preservation of food crops. Mechanization can increase yields through the improvement of water control, better soil preparation for planting, more efficient weed and insect control and the proper harvesting, handling, drying, storing and processing of food, feed and fiber crops. So that, agricultural mechanization is the art and scientific application of mechanical aids for increased production and preservation of food and fiber crops with less drudgery and increased efficiency.

Mechanization in Indian agriculture was over emphasised since Green revolution onwards, due to timely completion of operations in HYVs cultivation. Because of this reason substitution took place from traditional equipment to modern machines. However, increasing in application of machines, leads to not only much
capital costs in agriculture production but also it noticed over
demand for energy inputs. On the whole it was observed that,
inputs demand increased drastically from 1970/71 onwards. On the
other hand agricultural machinery and power consumption was very
much impressive, i.e more over a period of time. This indicates
that, there will be a greater demand for energy sources in near
future. The present section will talk about the nature of
agriculture machinery and implements (mechanization) in Indian
agriculture with respect to selected states, its demand over a
period of time, and also look at the substitution possibilities of
different agricultural equipment.

It was observed from the analysis that, substitution between
agricultural equipment, i.e less efficient to more efficient took
place from 1966/67 to 1991/92 in Indian agriculture. For example,
the number of wooden ploughs were declining, where as iron ploughs
raised at faster rate. With respect to sugarcane crushers run by
bullocks were replaced by sugarcane crushers run by power. In case
of oil and electric pump sets, number of oil pump sets engaged in
agriculture declined, where as electric pump sets raised at faster
rate. The tractor population has also noticed to be highest in U.P
next comes Punjab, Tamil Nadu, A.P, Bihar, and West Bengal
respectively. The lowest tractor population was noticed in West
Bengal, where still traditional agriculture exists. Interestingly,
comparative analysis between two factors such as labour and
tractors showed that, except Punjab all other states have showed
positive relation, such that introduction of tractors did not
affected the labour force participation. Where as Punjab has
noticed a declining trend in labour force participation in
agriculture production. On the other hand still Bihar and West Bengal are depending much on traditional type of equipment, due to institutional set up.

7.4 FERTILIZER AND PESTICIDE CONSUMPTION IN INDIAN AGRICULTURES

Fertilizers play a vital role in the modern agriculture technology. Use of fertilizers in increasing food production was conspicuous during the last two and a half decades where the consumption of nutrients N, P, and K increased from 0.78 million tones (1965-66) to 10.3 million tones (1988-89). During this period the food grain production also increased to over 170 million tones from a level of 73 million tones. The projected food grain requirement of 240 million tones by the turn of the century is to be achieved mainly through fertilizer use and improved farm technology.

The introduction of HYVs in Indian agriculture from 1966 onwards, gave path to much demand of inputs. So that, it is very much essential as foremost discussion to identify the area under high yielding varieties, which again will provide a path to identify the nature of fertilizers and pesticides demand in Indian agriculture.

Several studies are available which attempt (1) to estimate the contribution of fertilizers to increased agricultural output over time or (2) to estimate the proportion of agricultural output which is accounted for by the fertilizer input. In general, the developing countries have only a small proportion of total food
output attributable to fertilizer use, but the contribution of fertilizer to subsequent increases in output is much higher. A more balanced relationship exists within most developed countries. The contribution of fertilizer depends heavily upon the sources of increased output—increased area brought under cultivation or increased yield per hectare cultivated. Although fertilizer applications may be necessary to bring new land under cultivation, its major influence acts through the yield-increasing component.

The commercial energy required to produce a pesticide can be substantial. The raw materials for modern pesticides mostly come from the petrochemical industry, and further inputs of energy are required in manufacturing. Thus pesticides are the most energy intensive agricultural input. Nevertheless, continued growth in the use of pesticides appears unavoidable. Their expanded use is particularly needed in developing countries, where crop loss (both pre- and post harvest) because of inadequate pest control are very large. The declining share of world pesticide use projected for the developed countries probably mainly reflects environmental concerns.

Nitrogen being an energy intensive and costly nutrient, it becomes necessary to plan for scientific and efficient use of nitrogenous fertilizers. The nitrogen requirements for different crops and varieties under various agro soil-climatic situations, promotion of efficient fertilizer materials, complementary use of organic, in-organic and biological sources of nitrogen, and a sound technology transfer programme should form essential components of the strategy to promote efficient use of
nitrogenous fertilizers.

In the scenario of agricultural modernization, fertilizers and pesticides are the important inputs to lift the agricultural production to larger extent. The former will act as a direct input in production, the later act as a external factor which decide the level of production. At the same time much energy can be consumed in the production of this inputs, which again used at higher level in the agricultural production in recent years. Higher consumption of fertilizers and pesticides accounts for large energy demand in agriculture sector. Due to this in the last two decades agricultural sector is experiencing high demand for energy resources.

Fertilizers absorption from soil can differ from crop to crop according to its biological structure. As we know the legume crop will demand less amount of fertilizers compared to other crops such as rice, wheat, jowar, sugar cane and cotton. According to ICAR (1987), fertilizer absorption can differ from crop to crop and region to region due to soil differences.

On the whole it is observed that, the rate of phosphate and potassium increasing at faster rate in Indian agriculture. But according to this study it has been observed that, the soil which have abundant potassium will demand less potassium, where as the soil which had scarce potassium demands more amount of potassium.

Fertilizer consumption is steadily increasing in Indian agriculture over a period of time. Due to this demand for
fertilizers increasing at faster rate in India. Especially chemical fertilizers consumption is increasing at faster rate than farm yard manures, in which chemical fertilizers will give immediate results in agricultural production.

Fertilizer consumption differs from state to state, according to their requirements and utilisation pattern under different crops. On the other hand soil differences between state to state will also influence the consumption of fertilizers.

Per hectare consumption of fertilizers are differing from state to state over a period of time since last two decades. Fertilizer consumption per hectare is one of the important component for deciding yield rate in agriculture production. Theoretically as Recardo said, land have original and indestructible powers, which have been slowly declined in recent years, due to over exploitation of land resource. To compensate this fertilizers came in to exist, so that much amount of fertilizer consumption pave a path to declining in yield structure in Indian agriculture.

Adoption of HYVs technology gave a path to much increase in pesticide demand in Indian agriculture, due to increase in plant diseases. To remove this pest problem pesticides and insecticides demand has been increased at larger extent over a period of time. As discussed above, pesticide production demands larger amount of energy, which again used in agricultural production. This shows a clear indication of energy demand in Indian agriculture.
7.5 ENERGY DEMAND AND ENERGY INTENSITIES IN INDIAN AGRICULTURE:

The demand for energy in agriculture is dependent on a variety of factors such as, rate and pattern of agricultural growth and cropping pattern, cropping intensity, the development of agricultural technologies, efficiencies and economics of energy utilisation, government policies, agro-climatic conditions, and inter and intra farm variabilities in relation to levels of technologies applied to various crops.

Agriculture is the business of capturing solar energy in growing plants and using the light, organisms sustained by that energy to produce food and fiber needed by human beings. Like most other aspects of alternative energy in agriculture, energy-efficient cropping is a long-range proposition. At least, it is for roost commercial farmers. There are short-term ways to conserve energy in crop production, irrigation, harvesting, and crop processing. But, for the most part, this involve trade-offs. Either production is decreased for all or part of the acreage of a substantial investment in alternative energy system is required to maintain production currently achieve by impact of purchased energy.

The main conclusions were drawn in this study are, In choosing among energy sources and uses for the rural areas of developing countries, we are concerned with scarce resources and their most economical allocation, both the natural resources of land, water, fertilizers, metals, and fuels, and the human resources of capital, labour, human energy etc. A second need for
new sources of energy is to reduce costs. The most expensive form of energy is human energy, as can easily be seen if we consider how much food it takes to keep a man going at hard manual labor. Animal energy is also expensive. Consider for example the opportunity costs of feeding bullock. A farmer can use part of his land to grow fodder for his bullock, but he could grow wheat of rice or corn on that same land.

According to this study, any energy source for developing countries at the present time should be manpower-intensive rather than capital-intensive. Its development should use people rather than capital because people are less expensive and more abundant than capital in most less developed countries.

The rate of energy consumption by different resources can be differ from crop to crop, due to the operations involved in crop production. Energy consumption in agriculture sector under principal crops was classified into direct and indirect energy sources, depends on the replenishment. So that, human, bullock, seeds, and FYM can be treated as renewable energy sources, whereas electricity, diesel, fertilizers, and farm machinery considered as non-renewable energy sources. Energy consumption by different sources were increasing at faster rate in Indian agriculture. Especially since 1966 onwards, the rate of energy consumption was very much high, which accounts more than 20% in all resources.

The source-wise average energy consumption under six crops considered here has witnessed interesting observations. Rice crop is demanding highest energy in the form of diesel, next comes to
fertilizers, electricity, and human labour. In case of wheat, highest energy consuming from fertilizers, next to diesel, seed, and human labour. In case of jowar, much energy used in the form of diesel, next comes to electricity, FYM, fertilizers, and human labour. Interestingly groundnut noticed highest energy from Farm Yard Manure, later comes to fertilizers, human labour, and diesel. Cotton crop demanding much energy from fertilizers, next to diesel, human labour, and seed. Where as sugarcane noticed greater energy from seed, later comes to diesel, FYM, fertilizers, and human labour.

On the whole it was observed that, sugarcane demanding highest energy per hectare, next comes to rice, groundnut, jowar, wheat, and cotton respectively. Regarding states wise picture showed that, with respect to Andhra Pradesh rice was demanding much energy, later comes to groundnut, cotton, jowar, and sugarcane. Bihar recorded highest energy demand in rice, next comes to wheat, and sugarcane respectively. Where as Punjab noticed highest energy in rice, next comes to wheat, sugarcane, and cotton. Tamil Nadu was witnessed much energy demand in rice, later comes to groundnut, sugarcane, and jowar respectively. In case of U.P, rice is demanding higher energy, which follows sugarcane, wheat, and jowar. West Bengal was recorded highest energy demand in rice, later comes to wheat, and sugarcane respectively. All India level picture showed that, rice was demanding higher energy, next comes to sugarcane, wheat, jowar, and cotton respectively. It is clearly indicating from the above analysis that wet crops like rice and sugarcane demanding higher energy while comparing with other crops.
Based on regression analysis, a relation was established between output, land, labour, draught power, oil engines, electric engines, tractors, fertilizers, pesticides, energy, and rainfall, to know the production relations between the inputs. The empirical results showed significant relationship with respect to output under selected crops and states. Inverse function was estimated for energy demand, to understand the very nature of energy role in production.

It was observed that the relationship between output and energy showed significant in some crops such as cotton, groundnut, but whereas in case of rice and sugarcane it was negative relation. It is often true that even though rice and sugarcane crops are more energy intensive, but due to lack of better irrigation as well as rainfall, the relation between energy and output showed negative for above said crops. It indicating that concentration on wet crops without providing enough water leads to less yields, which reflect the production with more demand for energy, leads to negative relation. To remedy this situation alternative food crops production has very much essential in Indian agriculture, which demands less water as well as energy inputs.

7.6 POLICY RECOMMENDATIONS:

After examining the energy demand in Indian agriculture with respect to selected states, one can come to the conclusion that, though the existing system of agriculture is fulfilling the basic
need of the country, i.e. food frontier, there were enough variations among the states. The main reason is that, the Government is certainly concentrating on intensive agriculture in order to fulfill the required amount of food grains for public utilization. Because of this concentration on intensive agriculture belts a lot of variation between one region to another region is noticed. Keeping this idea under consideration, some drastic steps are needed in order to eliminate energy demand variations among states. Some in depth steps can be suggested to counter this problem of energy demand variations between states in the near future. Those are as follows.

(a). First and foremost, concentration on wet crops are creating more pressure on water, fertilizers, pesticides, and other inputs. So, the policy should be to encourage alternative food grains, which demand less amount of water and other inputs.

(b). Yield level is not uniform in selected states and all India. To remove this problem, conducting demonstrations to the farmers for improving skills in application of various inputs is required. So, that yield level can be maintained properly among the states. Here Government should take some initiative step to improve the management skills for farmers.

(c). Cropping intensity is changing over a period of time in Indian agriculture. Due to this agriculture production become volatile in every alternative year. Cropping intensity can be improved by encouraging investments in agriculture sector for constructing new irrigation projects, which will boost the area
under irrigation in Indian agriculture.

(d). Government price policy towards various crops should be reexamined. It should encourage alternative food crops, which can reduce demand side pressure on energy in Indian agriculture in near future.

(e). Supplying of public owned agricultural machinery and implements to the backward states at cheaper prices. This should prevent the energy demand variations and input burden in agriculture sector in selected states and all India.

(f) Rainfall is almost volatile in every alternative year in Indian agriculture. Due to this concentration on ground water irrigation is increasing for meeting the water requirements to wet crops cultivation. Because of this problem use of energy resources drastically increased in recent years. To overcome this problem encouraging alternative dry land crops is very much essential in near future for maintaining balanced growth in Indian agriculture.

(g). It can be observed that, increasing production through modern agricultural technology will always demand more energy resources in Indian agriculture. For that the encouragement of alternative energy sources such as solar, wind, and some traditional sources of energies are acceptable alternatives for meeting the future challenges.

(h). Finally, the most important recommendation to the Government policy makers is that, one should take some policy measures to
encourage the consumption of alternative food grains by existing population. This will reduce the more pressure on important cereal crops, such as rice and wheat, which demands larger amount of water as well as inputs. As stated by Foreign Economists, when the researcher visited for interaction on subject mater, she told that "solving food problem in Indian is difficult task". In the sense that each and every Indian(irrespective of their income) will consume much amount of rice and wheat without concentrating on any other alternative cereal crops. This is the important reason in the sense that, Indian agricultural facing draught conditions in every alternative year, this reflects less agricultural production, even though much amount of energy is consumed. Due to this reason it is suggested that, concentration on dry land crop cultivation is very much essential to meet the requirements of the existing population. This indicates, in near future Indian agricultural production and food consumption will concentrate on alternative food grain crops such as Bajra, Oats, and Jowar. This is a good symptom, in the sense that dry land crops will demand less amount of energy resources while comparing with wet crops. This type of policy implementation may solve the problem of food as well energy crisis in Indian agriculture.

(i). It has been noticed that, the most serious resources deficiency likely to diminish the prospects for bridging the gap between potential and actual farm yield will be energy. Apart from steps such as enhanced efficiency in energy conservation and use, and improved biological nitrogen fixation, the following are the other possible strategy measures.
1. Find un-discovered fuel resources.
2. Fully exploit renewable energy resources like bio-gas and biomass and hydel, and wind power.
3. Step up R & D efforts in solar energy harvest utilization, and
4. Develop nuclear power as a major source of energy.

Thus by considering the above mentioned recommendations, the energy demand variations between states can be reduced. At the same time the irrigation facilities have to be improved to fulfill the basic need of the country. Alternative energy sources like solar, wind, and other non-conventional etc., should be explored, so that the energy demand in future should be in a balanced manner.

7.7 LIMITATIONS OF THE STUDY:

The present study was undertaken with the view to examine the energy demand in Indian agriculture along with selected states. There are some drawbacks or limitations in the present study, which can be stated, in the following manner,

(a). The data used in this study was collected from Government records, which may be considered as reliable in this respect. But a primary survey may be a better alternative even though it has some limitations.

(b). In India there is no institution providing basic data relating to the crop wise energy demand. Here the crop wise energy demand values are taken from ICAR(1988) project reports. This is
generally considered as reliable in this study. An individual survey in this regard is more preferable.

7.8 DIRECTIONS FOR FUTURE RESEARCH:

In sum, the researcher identified certain areas in which future research has to be streamlined and geared. In the first place there always exists a growing gap between the micro level studies and macro level studies. Here nearly 80% of the research has been conducted at the micro level, which is not in conformity with the aggregate macro level observations. To bridge the gap, future research work has to be reoriented and channelised with a view to derive more realistic and fragmatic results.

Secondly, this study has identified that the Post Green-revolution symptoms certainly manifest that the energy consumption might more than 20%, which may increase future, Hence the logical conclusion that one derives is that though our energy resources are much more efficient, we are unable to reap the desired fruits of benefits due to the vagaries of monsoon with unpredictable and uncertain water availability.

Thirdly, almost all the studies hypothesized that there exists a direct relationship between energy demand and food production. As diametrically antagonistic to their views our present study has established that the direct relationship has been falsified in case of certain crops, especially in case of wet crops like rice, sugarcane, etc due to draw backs in yield.
Finally, there exists some structural imbalance between energy demand and yield (productivity). The reason behind this is that through our energy system seems to be much efficient, it has been proved to be inefficient which ends in fiasco owing to the prevailing unprecedented and unpredictable draught conditions.

Hence the future research should be streamlined and reoriented not on the basis of alternative energy sources but it should be organized on the basis of the alternative food crops which will be draught resistant by becoming a constant reservoir of energy in providing alternative food grains to the teeming millions of people, which confront draught conditions every now and then. This will serve our two fold purposes of energy requirements as well as food supply.