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Non-Conventional Energy Sources in Agriculture in Haryana (India)

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Abstract: ***The agriculture of India has undergone a dramatic transformation since independence due to the introduction of modern scientific inputs. Having achieved self-sufficiency in food production at aggregate level, agriculture is now required to diversify the fields of production for income generation, employment expansion, poverty alleviation and export promotion. Haryana State has the prime position of being one of the major contributors to the central food-grain pool of India. The increased use of energy builds up the productive capacity of agriculture and is the main sources of sustained agricultural growth. The structure of energy consumption in agriculture in Haryana has changed substantially, with a huge shift from animal and human labour towards tractors for farming operation and electricity and diesel used for groundwater irrigation. But the temporal use of different sources of energy inputs in agricultural production has to be empirically analyzed and inferences drawn so as to develop future strategies to create conditions for sustainable pattern of development. The overall performance of energy use from non conventional sources in Haryan's agriculture has been spectacular. The changes in the number of tractors and Tubewells & pumping sets, power consumption, pesticides and fertilizers are depicted. the use of fertilizers has increased tremendously. The Herfindahle indices of Tractors, tubewells, pumping sets, power consumption, pesticides and fertilizers have been increased to 5563.93, 2913.18, 9120.65, 1483.51 and 10699.39 respectively in 2011-12.***

Keywords: Energy sources, agriculture, Haryana, fertilizers, pesticides, power consumption

1. Introduction

Energy is a vital input for social and economic development (Wijarso 1983). As a result of the generalization of agricultural, industrial and domestic activities, the demand for energy has increased remarkably, especially in emergent countries (Khoshoo 2007). However, most of the world's energy sources are derived from conventional sources-fossil fuels such as coal, oil, and natural gases (Mishra *et al.* 1995). These fuels are often termed non-renewable or conventional energy sources. Although, the available quantity of these fuels are extremely large, they are nevertheless finite and so will in principle 'run out' at some time in the future (Rani *et al.* 2009). In the quest to sustain galloping economic activity, the dependence on coal and oil has soared at a phenomenal rate over the years. The problem will be compounded due to fast depletion of fossil fuel deposits, quality of fuels, heavy price to be paid for basic materials plus their transportation cost and above all the environmental degradation caused by the use of conventional energy sources (Tomer and Kapoor 1998). Under such conditions, environment friendly and pollution-free, non-conventional and renewable energy sources known as 'clean and green energy' have emerged as important alternatives to conventional energy sources (Kumar *et al.* 1985, Vanita 2012). The renewable energy sources are clean and inexhaustible as they rely on sun, wind, water, biomass, etc., as primary sources of energy. Renewable energy sources are essentially flows of energy, whereas the fossil and nuclear fuels are, in essence, stocks of energy (Gangwar 1998, Gupta *et al.* 1980).

Adequate capital investments and intensive research and development must be undertaken to provide adequate future energy for the future generations of Asian countries (Vidyanathan 1980, Singh and Singh 1991). Efforts are in progress for creating awareness among the people for use of non-conventional energy resources even in the country like Indonesia where oil is abundant and heavily subsidized keeping in mind environmental sustainability (Chand *et al.* 2007, Go 2010). Seventy percent of India's population lives in its rural areas distributed over 580,000 villages. Obviously, a substantial portion of the total energy demand in the country is in rural sector (Gupta and Singh 1996). In the absence of conventional energy supply the rural economy lacked adequate growth. For rural areas, energy planning involves use of a mix of locally available renewable resources with some conventional resources to meet the energy needs of the population.

The agriculture of India has undergone a dramatic transformation since independence. This significant development was due to the introduction of modern scientific inputs and the use of high yielding variety seeds (HYVs), controlled irrigation, chemical fertilizers, plant protection chemicals (insecticides and pesticides) and mechanical power in tested management packages (Kumar *et al.* 1985). Agricultural development can be measured by looking up at the increased production year after year and infrastructure development can be analyzed with the facilities associated with it. So, the increase in number of tube-wells, tractors, fertilizers and pesticides can be a good parameter to measure the development in agriculture (Dendukuri and Mittal 1993).

Haryana state has the prime position of being one of the major contributors to the central food-grain pool of India (Pandey *et al.* 1981, Sardana *et al.* 1997). This paper describes in brief about these non-conventional energy sources and their usage in agriculture in Haryana (India).

2. Materials and Methods

2.1 Study Area

Haryana is one of the smallest States and also, agriculturally dominant northern state of India situated between 27°37' to 30°35' Latitude and between 74°28' to 77° 36' Longitude, covering an area of about 44,212 km^2. It occupies 1.35% of the total geographical area of the country having 17th position in area (having 4.4 million hectares of land) among 28 states. The cropping intensity in the state is more than 180 percent, which indicates that the state has cropping intensity higher than the national average.

2.2 Data Collection

The inferences drawn from this study are based on secondary data collected from various issues of statistical abstracts of Haryana, published by the Directorate of Economics and Statistics, Government of Haryana and the Agricultural Statistics at a glance, published by Ministry of Agriculture, Government of India.

Figure 1: Map of India showing location of Haryana State

3. Results and Discussion

Notwithstanding significant progress in manufacturing and service sectors, agriculture sector continues to play a major role in the State economy contributing about 14.5 percent to its Gross Domestic Product (GDP) as well as providing employment to 51 percent of the work force (Vidyanathan 1980). Even in case of industrial employment, agriculture based industries account for more than 31 percent.

The overall performance of energy use from non conventional sources in Haryana's agriculture (Rani *et al.* 2009, Tomer and Kapoor 1998) has been spectacular. The changes in the number of tractors and Tubewells and pumping sets, power consumption, pesticides and fertilizers are depicted in the Table no. 1.

In this table, it is shown that the number of tractors in Haryana in 1966-67 was 4803 which was raised to 2.7 lakh in 2012-13 (Vanita 2012). The number of pumping sets and tubewells was 25311 in 1966-67 which increased tremendously in 2012-13 to 752357. Similarly, the power (electricity) consumption in the agricultural sector was 985.07 lakh KWH in 1966-67 (Vanita 2012) and it was reported to be 80827.50 lakh KWH in 2012-13 increasing continuously (Table no.1, Fig. No. 2,3). The use of pesticides in technical grade was 273 tonnes in 1966-67 and in 2012-13 it was 4050 tonnes which shows a fluctuation in its use by the farmers. The use of pesticides first increased up to 1990-91, but in recent years, their use is restricted to a limit, which shows that pesticides have harmful effects also on agriculture system. The fertilizers (nutrients) were consumed tremendously as 13347 tonnes in 1966-67 and increased to 1428048 tonnes in 2011-12, but it also decreased on a value of 1428048 tonnes in 2012-13. The relative share of tractors, tubewells, pumping sets, power consumption, pesticides and fertilizers (Fig. No. 3) have been increased to 5626.27, 2972.45, 8205.25, 1483.51 and 10137.56 respectively in 2012-13 (Wijarso 1983, Sardana *et al.* 1997).

The phenomenal growth in agriculture consumption is demonstrated by the growth in the number of electric pumps-sets/tube-wells. For agriculture private sector tube wells grew fast but government sector tube wells and agricultural lift reduce over time (Chand *et al.* 2007). As we see from 2010-11 private tube wells are 491807 but agricultural governments is 44 and agricultural lift is 90. It means people are spending money in the private sector for the development of agricultural sector and making agricultural sector associated with facilities (Khoshoo 1998, Kumar *et al.*

1985). But there are still problems related to agricultural sector left for the economy of Haryana (Mishra *et al.* 1995). Although connections in agricultural sector grew fast as we see in 1966-67 the numbers of connections were 20,190. After a certain time in 1985-86 connections were 2, 77,327 and in 2010-11 it became 5, 20391.

Table 1: Changes in Non-conventional Energy Sources in Agriculture

Years	Tractor (Numbers)	Tubewells & Pumping sets (Numbers)	Power consumption (lakh KWH)	Pesticides technical grade (Tonnes)	Fertilizer nutrients (Tonnes)
1966-67	4803 (100.00)	25311 (100.00)	985.07 (100.00)	273 (100.00)	13347 (100.00)
1970-71	12312 (256.33)	104358 (412.30)	2985.72 (303.09)	412 (150.91)	70060 (524.91)
1975-76	25451 (529.89)	204736 (808.88)	5945.83 (603.59)	1400 (512.82)	96915 (726.11)
1980-81	52689 (1029.00)	332027 (1311.78)	9537.71 (968.22)	2150 (787.54)	230823 (1729.39)
1985-86	83120 (1730.58)	406418 (1605.69)	13664.94 (1387.20)	3608 (1321.61)	372187 (2788.54)
1990-91	130246 (2711.76)	497571 (1965.82)	27117.77 (2752.87)	5164 (1891.57)	586292 (4392.68)
1995-96	162030 (3373.51)	549296 (2170.01)	39043.26 (3963.50)	5100 (1868.13)	723787 (5422.84)
2000-01	209613 (4364.20)	589473 (2328.92)	47559.38 (4828.02)	5025 (1840.65)	930295 (6970.06)
2004-05	239814 (4993.00)	611598 (2416.33)	56825.13 (5768.63)	4700 (1721.61)	1124688 (8426.52)
2005-06	246914 (5140.82)	618023 (2441.71)	62547.40 (6349.53)	4650 (1703.29)	1128671 (8456.36)
2010-11	262236 (5459.83)	723457 (2858.27)	80973.40 (8220.06)	4060 (1487.17)	1357622 (10171.73)
2011-12	267236 (5563.93)	737357 (2913.18)	89844.82 (9120.65)	4050 (1483.51)	1428048 (10699.39)
2012-13	270230 (5626.27)	752357 (2972.45)	80827.50 (8205.25)	4050 (1483.51)	1353061 (10137.56)

Note: Figures in parenthesis indicate indices of changes over the period

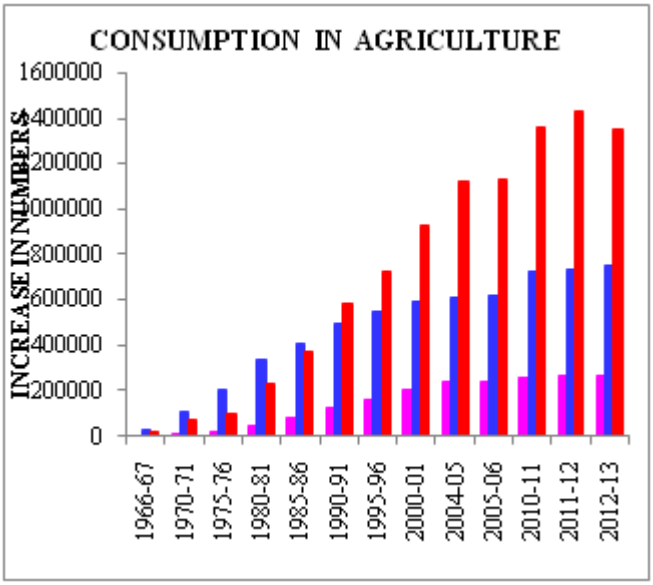

Figure 2: Increase in number of different sournces in agriculture in Haryana: Tractors (■), Tubewells and Pumping Sets (■) and Fertilizers (■).

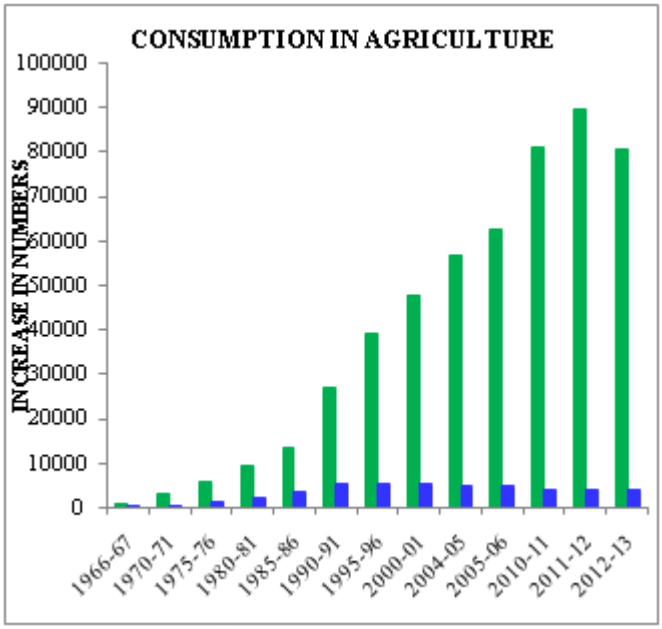

Figure 3 : Increase in number of different sournces in agriculture in Haryana: Power Consumption (■) and Pesticides (■).

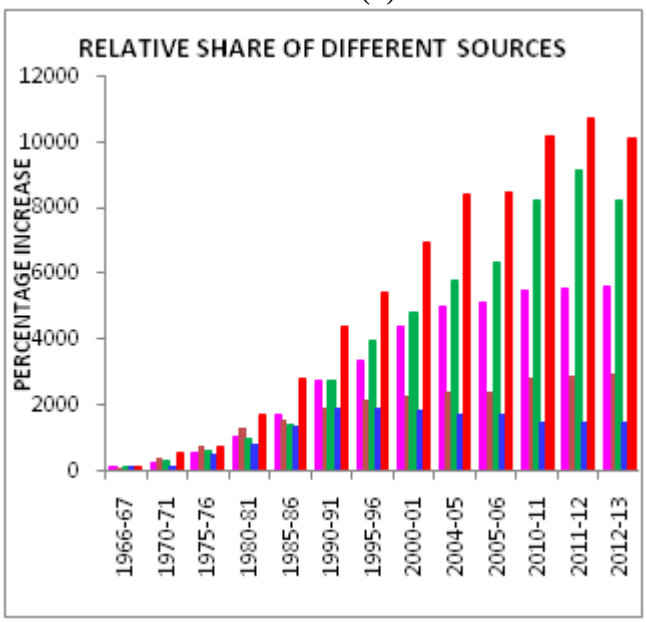

Figure 4: Percentage increase in the relative share of different sournces in agriculture in Haryana: Tractors (■), Tubewells and Pumping Sets (■), Power Consumption (■), Pesticides (■) and Fertilizers (■).

4. Conclusion

The increased use of energy builds up the productive capacity of agriculture and is the main sources of sustained agricultural growth. The structure of energy consumption in agriculture in Haryana has changed substantially, with a huge shift from animal and human labour towards tractors for farming operation and electricity and diesel used for groundwater irrigation. But the temporal use of different sources of energy inputs in agricultural production has to be empirically analyzed and inferences drawn so as to develop future strategies to create conditions for sustainable pattern of development.

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