Energy Consumption Pattern in Wheat Production in Sindh Pakistan

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Abstract
Wheat (*Triticum aestivium L.*) is the main staple food for most of the population and largest grain source o the country. It occupies the central position in formulating agricultural policies. It contributes 13.1 percent to the value added in agriculture and 2.7 percent to GDP. Area and production target of wheat for the year 2012-13 had been set at 9045 thousand hectares and 25 million tons, respectively. Wheat was cultivated on an area of 8805 thousands hectares, showing a decrease of 3.6 percent over last year's area of 9132 thousand hectares. However, a bumper wheat crop of 24.2 million tons has been estimated with 3.9 percent increase over the last year's crop of 23.3 million tons. The prospects for wheat harvest improved with healthy fertilizer off-take and reasonable rainfall during pre-harvesting period. Energy is a necessary of life for human beings all over the world due to its function in strengthening the security and contentment of the people. Energy demand is growing with the passage of time due to infrastructural and industrial development. Energy is required to perform all the human activities. It is need for food preparation, water heating and cooling, for lighting, for production of goods etc. The study was focused on all types of energy (fossil fuels, chemicals, animals dung, animate etc). A sample of 60 farmers was selected from study area. A pre tested questioner was used to collect data from selected respondents through personal interviews. Descriptive statistics and Cobb-Douglas production function was applied to analyze the data. Result shows that wheat farmer achieved highest amount of net energy which was calculated as small, medium and large farmers is 1368336.88, 1698003.79 and1702527.75 MJ/acre respectively. In production of wheat large, medium and small farmers achieve amount of net energy which was calculated 41525.06, 38590.99, 39095.33 MJ/acre. The impact of various energy inputs on yield was studied. The share of various energy types in total cost of production was estimated. Commercial energy (diesel and electricity) consumed highest amount of energy in production of wheat.
Keywords: Wheat, Energy Consumption, Commercial energy and Production.

Introduction

Wheat (*Triticum spp.)* is a cereal grain, originally from the Levant region of the Near East and Ethiopian Highlands, but now cultivated worldwide. In 2010, world production of wheat was 651 million tons, making it the third most-produced cereal after maize (844 million tons) and rice (672 million tons). Pakistan, which has been exporting wheat for the last three years, joins a growing list of countries that have seen production curbed, squeezing global supplies and buoying prices. Pakistan is likely to ship in 800,000 tonnes to 1 million tonnes of wheat in the year to March 2014, traders said, the most since 2008-09 and way up from the 200,000 tonnes bought last year. Supply will mainly come from the Black Sea region due to competitive prices offered there. We are have just finished the harvest and one would imagine that everything is alright but prices are moving higher," said a Karachi-based grains trader. "There is shortfall in the market as our production was well below the government's target and there has been drawdown in stocks." Wheat production in Pakistan slid to 23.3 million tonnes in 2012-13, the lowest in four years and down from 25 million tonnes a year ago, according to the US Department of Agriculture. Output in 2013-14 is estimated at 24 million tonnes (DAWN, 2014).

Wheat is the major staple food in Pakistan and is used for different purposes. As this crop is also very important for the economy because it has contributed 12.1 percent of value added in agriculture and 2.6 percent in the total GDP of Pakistan. Despite these changes, agriculture is still the single largest sector of Pakistan's economy. Almost 45 percent population of Pakistan receives employment from this sector. Furthermore, the population living in rural areas of Pakistan accounts for more than two-thirds of its total population and 60 percent of this population is dependent on agriculture and its allied industries for their livelihood (GOP, 2012).

In Pakistan, wheat being the staple diet is the most important crop and cultivated on the largest acreages in almost every part of the country. It contributes 14.4 percent to the value added in agriculture and 3.0 percent to GDP. Over the past three decades, increased agricultural productivity occurred largely due to the deployment of high-yielding cultivars and increased fertilizer use. With the introduction of semi-dwarf wheat cultivar, wheat productivity has been increased in all the major cropping systems representing the diverse and varying agro-ecological conditions. Pakistan has been divided into ten production zones because of great agro ecological areas where wheat is grown (NARC-2012)

Comparing simulated and measured values using For example, reducing the energy derived from fossil fuels within agricultural systems has important implications for decreasing atmospheric emissions of greenhouse gases, thus assisting the mitigation of global warming. The identification of crop production methods, which maximize energy efficiency and minimize greenhouse gas emissions, is vital (Tzilivakis *et al.* 2005).

Energy has an influencing role in the development of key sectors of economic importance such as industry, transport and agriculture. This has motivated many researchers to focus their research on energy management. Energy has been a key input of agriculture since the age of subsistence agriculture. It is an established fact worldwide that agricultural production is positively correlated with energy input Agriculture is both a producer and consumer of energy. It uses large quantities of locally available non-commercial energy, such as seed, manure and animate energy, as well as commercial energies, directly and indirectly, in the form of diesel, electricity, fertilizer, plant protection, chemical, irrigation water, machinery etc. Efficient use of these energies helps to achieve increased production and productivity and contributes to the profitability and competitiveness of agriculture sustainability in rural living. Energy use in agriculture has been increasing in response to increasing population, limited supply of arable land, and a desire for higher standards of living (Singh *et al*. 2002).

The excessive use of energy in developed and developing countries have created several environmental, commercial, technical, and even social problems, which requires in depth investigation in order to mitigate ensuing negative impacts. Analyzing all the relevant information is necessary to reduce the energy consumption and its environmental impacts. Energy is one of the important elements in modern agriculture as it heavily depends on fossil and other energy resources. Energy consumption in agriculture has been increasing in response to the limited supply of arable land, increasing population, technological changes, and a desire for higher standards of living (Kizilaslan, 2009).

In contrast to other sectors, the energy use in agriculture has generally received very little attention from scientists in different countries. The main reasons for this little scientific attention are data shortage and lower level of multi-disciplinary work, implying that researchers give little attention to marginal subjects of science. However, energy use in agricultural production has been increasing faster than in many other sectors (Karkacier *et al.* 2005).

It is clear that energy use in modern agriculture has increased; however, this has produced the intended result of increased rate of production. The modern agriculture has made it possible to reduce the energy use per unit of production (Sauerbeck, 2001).

Some studies show that there is a positive relationship between energy usage and productivity (Outlaw *et al*. 2005). Also, there is a significant relationship between energy output and weather, price, yield, and technology. Some of the energy sources in agriculture sector are classified in other sectors; for example, fuel consumption in farm operations sometimes feature in the transport sector, or indirect energy sources (fertilizers, seeds, and agrichemicals) have become part of the industrial sector. Consequently, official national statistics do not usually show accurate energy use in agriculture and do pay very little attention to energy consumption in the agriculture sector. Energy use is one of the key indicators for developing more sustainable agricultural practices. Renewable energy sources coming from agricultural crops could play an important role to supply the energy requirement and in terms of environmental effects (Qasemi *et al.* 2013).

Energy use in based production system, potato in India wheat, agriculture has developed in response to increasing maize, sorghum in United States cotton, sunflower in populations, limited supply of arable land and desire for Greece oilseed rape in Germany. An increasing standard of living .In all societies, this Proper use is water which is vital element for the growth of crops but requires energy for its application. It has been noted that water availability to agriculture is expected to fall from 72 % in 1995 to 62 % by 2020 globally and 87 % to 73 % in developing countries (Khan *et al.* 2006).

Energy auditing is one of the common and reliable approaches to examine energy use efficiency and its impact on the fossil fuel reserves. Moreover, energy auditing also provides sufficient information to understand the elasticity's of energy input and its influence on biomass production (Hatirli *et al.* 2006).

Energy budgets for agricultural production can be used as building blocks for life cycle assessments that include agricultural products, and can also serve as a first step towards identifying crop production processes that benefit most from increased efficiency (Piriner, 2006).

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Agriculture is both a producer and consumer of energy. It uses large quantities of locally available noncommercial energy, such as seed, manure and animate energy, as well as commercial energies, directly and indirectly, in the form of diesel, electricity, fertilizer, plant protection, chemical, irrigation water, machinery etc. Efficient use of these energies helps to achieve increased production and productivity and contributes to the profitability and competitiveness of agriculture sustainability in rural living (Singh *et al*. 2002).

Energy use in agriculture has been increasing in response to increasing population, limited supply of arable land, and a desire for higher standards of living (Kizilaslan, 2009).

The increased use of inputs such as fertilizer, irrigation water, diesel, plant protection chemicals, electricity etc. demands more energy in the form of human, animal and machinery. The commercial energy used in agriculture increased nearly six fold with growth rate of 11.8% between1980-81 to 2000, but the share of agriculture in total energy consumption in the country increased 2.3 to 5.2% during the same period (Surendra Singh, 2002).

Study on energy consumption pattern in transplanted paddy cultivation. They reported that, irrigated farms consumed 57 to 201% more energy mainly through electricity, fertilizer, and diesel as compare to rain fed farms and resulted in to 20.4 to 67.3% higher crop productivity. Operational energy use was 40 to 50% of the total energy usage. Irrigation was the most energy consuming operation in irrigated farms followed by tillage, harvesting threshing and transplanting (Hatirli *et al.* 2005).

Energy use in agriculture can be divided into direct and indirect, renewable and non-renewable. A combination of both the renewable and non-renewable source of energies like fossil, solar, wind, biodiesel and bio-ethanol are needed to successful production. Seemingly, the more use of renewable energies would result in more sustainable production if environmental and socio-economic side-effects are considered well (Houshyar, 2012).

Agriculture uses energy directly as fuel or electricity to operate machinery and equipment, to heat or cool buildings, and for lighting on the farm, and indirectly in the fertilizers and chemicals produced off the farm. Effective energy use in agriculture is one of the conditions for sustainable agricultural production, since it provides financial savings, fossil resources preservation and air pollution Reduction (Uhlin, 1998).

Energy use in the agricultural sector depends on the size of the population engaged in agriculture, the amount of arable land and the level of mechanization. The more energy particularly fossil energy use in agriculture would result in low sustainability of agricultural systems in addition to environmental pollutions. Energy and environmental security are major problems facing our global economy (Barbir *et al.*2007).

Wheat is an essential staple and strategic crop in Iran with a total annual area of 6.9 million hectares of which near to 48% is rained. However, only 25% of total yield comes from rain fed wheat farms. A huge energy and budget are allocated to this crop to reach a sustainable yield and self-sufficiency. Farmers use more and more energy to increase output; nonetheless, the average output especially in rain fed regions is not satisfying. Tillage is a main operation in a crop production system that affected the crop yield, soil quality and energy input (Claus *et al.* 2005)

The relation between agriculture and energy is very close. Agricultural sector itself is an energy user and energy supplier in the form of bio-energy. It uses large quantities of locally available non-commercial energies, such as seed, farmyard manure and animate energy, and commercial energies directly and indirectly in the form of electricity, diesel fuel, chemical fertilizers, plant protections, irrigation water and farm machinery (Kizilaslan, 2009).

Nowadays, energy usage in agricultural activities has been intensified in response to continued growth of human population, tendency for an overall improved standard of living and limited supply of arable land. Consequently, additional use of energy causes problems threatening public health and environment (Rafiee *et al.* 2010).

However, increased energy use in order to obtain maximum yields may not bring maximum profits due to increasing production costs. In addition, both the natural resources are rapidly decreasing and the amount of contaminants on the environment is considerably increasing (Esengun *et al.* 2007).

Efficient use of energy resources in agriculture is one of the principal requirements for sustainable agricultural productions; it provides financial savings, fossil resources preservation and air pollution reduction; for enhancing the energy efficiency it must be attempted to increase the production yield or to conserve the energy input without affecting the output (Singh *et al.* 2004).

Therefore, energy saving has been a crucial issue for sustainable development in agricultural systems. Development of energy efficient agricultural systems with low input energy compared to the output of food can reduces the greenhouse gas emissions from agricultural production systems. Improvements in the efficiency of resource use in agriculture require not only the definition of spatial and temporal use of current resources but also the development of tightly defined and broadly applicable indices (Topp *et al.* 2007).

Energy productivity is an important indicator for more efficient use of energy although higher energy productivity does not mean in general, more economic feasibility. The energy input-output analysis is usually made to measure the energy efficiency and environmental aspects. This analysis will determine how efficient the energy is used. In current years, several researches have been conducted on energy use for production of different agricultural crops (Mohammadi *et al.* 2010).

Moreover, in some studies the parametric and non-parametric approaches have been used to analyze the efficiency of farmers in agricultural productions. In parametric approach, an econometric model is used to identify the relationship between energy inputs and yield values of crop productions. In this method, the parameters of the production or cost functions are estimated statistically. Establishing the functional forms between energy inputs and output for agricultural crops are very useful in terms of determining elasticity of different energy inputs on yield (Turhan *et al.* 2008).

The sensitivity analysis of energy inputs on crop production is essential because it revealed what changes in energy inputs cause greater impacts on the output. Furthermore, it is of special importance for the policy-makers to frame suitable policies for improving energy use efficiency (Lamoureux *et al.* 2006).

Analyzed the energy efficiency of soybean producers using parametric approach . In this study the Cobb-Douglas production function was applied to develop an econometric model between inputs and output. The inputs were human labor, machinery, diesel fuel, chemicals, fertilizers, water for irrigation, electricity and seed energies; while, the soybean yield was the single output. Data Envelopment Analysis (DEA) is a non-parametric linear programming (LP) based technique of frontier estimation for measuring the relative efficiency of a number of decision making units (DMUs) on the basis of multiple inputs and outputs (Zhang *et al.* 2009).

Energy has been a key input of agriculture since the age of subsistence agriculture. It is an established fact worldwide that agricultural production is positively correlated with energy input. Agriculture is both a producer and consumer of energy. Energy input–output analysis is usually used to evaluate the efficiency and environmental impacts of production systems (*Ozkan et al. 2004*).

Energy use in agriculture has been increasing in response to increasing population, limited supply of arable land, and a desire for higher standards of living. In modern agriculture system input energy is very much higher than in traditional agriculture system, but energy use efficiency has been reduced in response to no affective use of input energy. Efficient use of energies helps to achieve increased productivity and contributes to the economy, profitability and Competitiveness of agriculture sustainability in rural areas (Ozkan *et al.* 2004)

These can only be done by supplementing the traditional energy input i.e. human labour with substantial investments in farm machinery, irrigation equipment, fertilizers, soil and water conservation practices, weed management practices, etc. These inputs and methods represent various energies that need to be evaluated so as to ascertain their effectiveness and to know how to conserve them. Energy analysis, therefore, is necessary for efficient management of scarce resources for improved agricultural production. It would identify production practices that are economical and effective. Other benefits of energy analysis are to determine the energy invested in every step of the production process (hence identifying the steps that require least energy inputs), to provide a basis for conservation and to aid in making sound management and policy decisions (Bebendra, 2008)

In agriculture sector of India, the energy use pattern for unit production of crops has varied under different agro climatic zones. The use of energy in crop production depends on availability of energy sources in particular region and also on the capacity of the farmers. There is a need to carry out energy analysis of crop production system (practices) and to establish optimum energy input at different levels of productivity. The appropriate use of energy input to crop production could originate from several types of conservation practices. The reduction, elimination or combination at machinery operation will reduce energy (fuel) input and also may reduce the uses of labor and time (Karale *et al.* 2008).

The research aimed to performed an analysis of energy consumption pattern in wheat production in district Shaheed Benazir Abad (Nawabshah) Sindh of Pakistan. This study was therefore taken up keeping in view the following objectives:

Objectives

The main objectives of the present study are as under:

1. To investigate the energy use in wheat production and its impact on crop yield.
2. To determine the impacts of different factors on energy use.
3. To estimate net energy gain from wheat.
4. To sort out the difficulties faced by selected farmers in study area and to recommended appropriate suggestions.

Materials and Methods

The study was carried out to investigate the total energy used in production of wheat and its impact on crop yield in the district Shaheed Benizarabad (Nawabshah) of Sindh. The study focused on the net energy gained by estimating total energy used in production of wheat and total energy gained from wheat .Moreover, to determine the impacts of different factors affecting energy use in production of wheat was other objective of the study.

Research Design

Study Area

The study was based on primary data. The data was collected through field survey using face to face interview with farmers simple 60 producers of wheat was selected Small, medium and large farmers were selected from each of two taluka so that sample could represent all categories of farmers.

Methodological Framework

The study was carried out by the use of primary data from the wheat growing farmers. This section contains two major segments. The first segment includes sampling method and data collection while analysis of the data is described in second segment.

Sample Size

Population of any area contains all people and items with individuality one can recognize and it needs quiet a time and money to collect information from everyone and everything living in a population even not feasible sometimes. This issue can be solved by selecting a sample from required population which provides average conditions and can represent the whole (David and George, 2005). It is suggested that sample selection should contain least blunders and standard error (Casley and Kumar, 1988).

Data Collection

Out of two taluka, 30 respondents from each taluka were selected. The two randomly selected taluka were consisted of 20 union councils. Out of 20 union councils four union councils taken into account. From these union councils eight villages were taken into account to investigate the impact of energy use on crop yield and find out total energy used in production of wheat.

Questionnaire Development

In all statistical surveys questionnaires are considered as the medium for recording the information obtained in a standardized manner. Keeping in view the energy consumption pattern in wheat production a comprehensive questionnaire was developed; Questionnaire included important questions to obtain information about energy consumption pattern in wheat production along with other socio-economic characteristics of the farm house hold.

Collection of Data

Information about energy consumption and other necessary aspects was collected crop and operation wise, by employing comprehensive and pre tested questionnaire. In order to enhance the response rate, data was collected through interview .Although questionnaire was prepared in English language while the interview with respondents was done in local language i.e. Sindhi. Different features were covered in the questionnaire.

Data Analysis

Collected data had both quantitative and qualitative information. So it was analyzed by following analytical measures. For data analysis Microsoft Office Excel software package and SPSS 17 package were used.

Descriptive Statistics

To analyze the data, descriptive statistics technique was used to find out the mean and frequencies of different energies used and price of input and outputs. Average was calculated using following formula which was also used by Kyeyamwa *et al.* (2008).

$AM = \sum X / N$

Where,

AM =Arithmetic Mean

X = Value of Variables

N = Number of Observations

$\sum$ = Total Sum of variables

Percentages

Percentage is the proportion of fraction articulated in hundredth. It was computed by

$P = F / N * 100$

Where,

P = Percentage

F = frequency of desired class

N = Total number of respondents

Socio Economic Characteristics

The status of the sample respondents can be well described through socio economic characteristics. In this study, different indicators of respondent's socio economic features identified:

Age

Age factor plays an important role on the workability and efficiency of the person's contribution in different farm and nonfarm operations. In this study the age information is gathered in years.

Education

Education is taken to be a most important feature of respondent's status which describes its awareness, approach and reputation. In this study education of the respondents is expressed in years which he spent in any institution for gaining knowledge.

Farming Experience

Farming experience has its impacts on the farm production. With the passage of time a person gains experience and gets well familiar to the utilization of resources and the conditions of farm and output markets. The more the experience a farmer gains it has positive effects on productivity and profitability. How experience affects the farm production is expressed in this study.

Family Size

Most of the labor to perform various farm operations is taken from farmer's family. Therefore family size of the farmer has a significant impact on productivity. Family size contains all those individuals who have a share in the yield and farm income.

Land Holding

Total land hold by the farmer on which it performs farm operation and from which he gets the income is called the land holding. Land holding involves the land owned or rented in or out by the farmer. In this study the total area owned by the farmer and area under wheat crop is taken in acres.

Energy Input-Output Relationship

In order to estimate the impact of energy consumption on the crop yield, regression analysis was employed using the various functional forms. There were different possible production functions, which were employed for explanting impact of energy use on crop yield i.e. DAE technique.

However , keeping in view the sign/ magnitude of the co-efficient, value of R^2 , t-values, etc, Cobb-Douglas production function was considered more appropriate for describing the situation.

The econometric model used was as under.

$Y = f(X1_{,} X2, X_3, X_4, X_5, X_6)$

Where,

Y = Yield of crop under consideration Energy Equivalent (MJ/Kg) per acre.

X_1 = Human Energy Equivalent (MJ/Hour)

X_2 = Machine Energy Equivalent (MJ/Hour)

X_3 = Nitrogen Energy Equivalent (MJ/Kg)

X_4 = Phosphate Energy Equivalent (MJ/ Kg)

X_5 = Diesel Energy Equivalent (MJ/ Kg)

X_6 = Seed Rate Energy Equivalent (MJ/ Kg)

Cobb Douglas Production Function

Different forms of the production function were tried. However keeping in view the sign and magnitude of the co-efficient, value of R^2 ,t-values ,etc. Cobb-Douglas Production Function was considered more appropriate for describing the situation.

This type of production function can be expressed in form of equation as under:

$Y = aX^b$ Single input case

$Y = aX_1^{b1} X_2^{b2} X_3^{b3} \ldots\ldots\ldots\ldots\ldots X_6^{b6}$ Multiple input case

Where,

Y = Stands for output Energy Equivalent (MJ/Kg) per acre

a = Stands for Y- intercept (constant)

$X1_{,} X2, X_3, X_4, X_5,$ *and* X_6 Stands for MJ energy used in form of level from different sources.

$b_{1,} b_{2,} b_{3,} b_4, b_5$ *and* b_6 Parameters to be estimated

Both sides of the function can be transformed to logarithms form:

$Ln\ Y = b_0 + b_1 lnX_2 + b_2 lnX_2 + \ldots\ldots\ldots\ldots + e$

Where, e stands for error term.

Net Energy Gain

Net energy gained was calculated by finding out total energy used in form of all inputs and total energy gained in form all crop outputs byproducts.

Net energy gain = Total energy gained – Total energy used.

Different Types of Energy used in Production of Wheat

Agriculture sector consumes different types of energies in different ways. These can be direct, indirect, renewable or non-renewable energies. Direct energy may include human power, animals, fuel, electricity, irrigation .Whereas; indirect energy is acquired from fertilizers, pesticides, herbicides and arm machinery. Renewable energies are human power, seed, manure etc. Non-renewable energies can include fuel, electricity, fertilizers, irrigation, farm machinery (Gravand *et al.* 2010).

Direct, indirect, renewable and non-renewable energy were estimated by multiplying these inputs by their respective energy equivalent in sampled area.

Results

The study area was Shaheed Benazirabad (Nawabashah) District of Sindh Pakistan. Total cropped area was represented by small, medium and large farmers.

The study is described into two subsections

1. Socio-economic characteristics
2. Energy consumption patterns in production of wheat.

Socio-Economic Characteristics

Age of the Farmers

Age is very important demographic factor which influences the efficient allocation of resources'. More aged people are more skillful and experienced than the less age people. Age factor plays an important role on the workability and efficiency of the person's contribution in different farm and nonfarm operations. In this study the age information is gathered in years.

Table 1: Age group of the different categories farmers

Age Category	Small farmer	Medium farmer	Large farmer
20-30 years	05	03	02
31-40 Years	10	04	06
41-50 Years	08	09	03
Above50 Years	07	02	01
Total	30	18	12

Table-1 according to the table that 10 farmers were between the ages of 20-30 years, 20 farmers were between the ages of 31-40 years, 20 farmers were between the age of 41-50 years and 10 farmers were between the ages of above 50 years .in the whole sample there is no child labour.

Education of the Farmers

It is expected that education has a positive effect on the behavior of farmers about the adoption of new innovations and improved technologies. Education is taken to be a most important feature of respondent's status which describes its awareness, approach and reputation. In this study education of the respondents is expressed in years which he spent in any institution for gaining knowledge.

Table 2: Education levels of the different categories of farmers

Education Category	Small farmer	Medium farmer	Large farmer
Illiterate	04	03	1
Primary	08	05	01
Middle/ Matric	10	04	03
Intermediate	07	04	05
Bachelor/Master	01	02	02
Total	30	18	12

Table-2 reveals that slightly 8 farmers were illiterate, while about 14 farmers were Primary level of education; the 18 were middle/matriculation. 16 farmers were intermediate and 05 farmers were bachelor/master education in the study area.

Marital Status

Marital status is the condition of being married, unmarried, married but living separately and apart from one's spouse, divorced or widowed.

Table 3: Distributions of respondents according to marital status

Marital Status	No. of Farmers	Percentage
Married	38	63.33
Single	22	36.66
Total	60	100.00

Table-3 Indicates that 38 respondents were married, which almost 63.33 % of the total. The result shows that they have the responsibility of their family, while the rest of 22 respondents were un-married, which is 36.66 % of the out of 60 respondents.

Family Size of Farmers

A fundamental social group is in society typically consisting of one or two parents and their children.

Table 4: Family sizes of the different categories of farmers

Family Members	Small farmer	Medium farmer	Large farmer
02-04 members	08	03	3
05-07 members	11	06	3
08-10 members	7	05	4
Above 10	04	04	2
Total	30	18	12

Table-4 exhibits the family size of the different classes of farmers. 14 respondents were 02-04 member's family size, 20 respondents were 05-07 members family size, 16 respondents were 08-10 members family size and 06 respondents were above 10 members family size respectively.

Tube well Owned

A tube well is a type of water well in which a long 100–200 mm (5 to 8 inch) wide stainless steel tube or pipe is bored into an underground aquifer. The lower end is fitted with a strainer, and a pump at the top lifts water for irrigation.Tube well is now a day s is primary source of irrigation in Pakistan. And most of the farmers have their own tube well now a day.

Table 5: Tube well status of the different categories of farmers

Farmer Category	No. of Farmers	Percentage
Small Farmers	11	36.33
Medium Farmers	10	55.55
Large Farmers	9	75.00

Table-5 shows that the 36.33 % small farmers have their tube well; almost 55.55 % medium farmers have their own. Whereas, most of the large farmers had having their own tube well 75.00 % which clearly shows the shortage of canal water for irrigation in the study area.

Tractor owned

Tractor is the main machine which performs all kind of agricultural tasks from ploughing, leveling, threshing and irrigation etc. the farmers are very poor in Pakistan due to every farmers cannot offered tractor.

Table 6: Tractor status of the different categories of farmers

Farmer Category	No. of Farmers	Percentage
Small Farmers	00	0.00
Medium Farmers	05	27.77
Large Farmers	7	58.33

Table-6 shows that 0.00 % of small farmers they not have own tractor .they used rented tractors for field operation. While ratio of having own tractor of medium farmers is almost 27.77 % while the large farmers 58.33 % had having their own tractors and others farmers also used rented tractors.

Land Holdings

Farmers in the study sample were classified into three categories so that average can truly represent all kinds of farmers.

Table 7: Land holding pattern of the different categories of farmers

Farmers Category	Average Land Holding acre
Small Farmers	3.30
Medium Farmers	9.10
Large Farmers	19.80

Table-7 the table which is given shows that 3.31 acre of small farmers they average land holding, the medium farmers was calculated 9.10 acre in the study area. Whereas, the average land holding of the large farmers was 19.80 acres in the study area.

Irrigation

Irrigation means the action of applying water to land in order to supply crops and other plants with necessary water. Sometimes nutrients may be applied via irrigation.

Table 8: Irrigation cost per acre in wheat production of the different categories of farmers

Farmers Category	Irrigation cost of wheat production(Rs)
Small Farmers	4232.93
Medium Farmers	4970.10
Large Farmers	5262.50
Sample/Average	4821.34

Table-8 the average irrigation cost per acre under wheat cultivation of small medium and large farmers was estimated about 4232.93, 4970.10, 5262.50 Rs respectively. The overall average irrigation cost per acre under wheat production of all three groups was estimated about 4821.34 Rs.

Fertilizer

Any of a large number of natural and synthetic materials, including manure and nitrogen, phosphorus, and potassium compounds, spread on or worked into soil to increase its capacity to support plant growth.

Table 9: Fertilizer cost per acre in wheat production of the different categories of farmers

Farmers Category	Fertilizer cost of wheat production(Rs)
Small Farmers	8330.50
Medium Farmers	8574.50
Large Farmers	10858.33
Sample/Average	9254.44

Table-9 the average fertilizer cost per acre under wheat cultivation of small medium and large farmers was estimated about Rs. 8330.50, 8574.50, 10858.33respectively. The overall average fertilizer cost per acre under wheat production of all three groups was estimated about Rs.9254.44.

Energy Consumption Pattern in Production of Wheat

Energy is a necessity of life for human beings all over the world due to its function in strengthening the security and contentment of the people. Its conservation promotes economic efficiency; improve the productivity and competitive of energy consuming enterprises. The study was focused on the impact of energy use in production of wheat and secondly net energy gained from wheat in form of output in the study area. Appropriate conversion factors were needed for converting various physical outputs such as Kg of fertilizers, liters of diesel and insecticides, day of labor or draft animals into common energy unit. Time standards for various farms operation such as ploughing, planking, sowing , weeding, irrigation and harvesting were needed for estimating the tractor animals or manual time consumed in various farms operations. Therefore the conversion units given in different studies were followed.

Different Types of Energy used in Wheat Production

Wheat is one of the most serial crops which requires huge amount of energy in form of different inputs.

Table 10: Different Types of Energies (MJ/Acre) used per acre

Category	Nitrogen	Seed	Phosphorus	Labour	Machine	Diesel
Small	5476.39	873.60	416.92	51.30	363.33	839.82
Percentages	68.27	10.89	5.20	0.64	4.53	10.47
Medium	5376.13	860.28	416.17	49.67	372.64	828.01
Percentages	68.03	10.89	5.27	0.63	4.72	10.48
Large	5955.02	853.32	397.78	51.02	387.67	828.54
Percentages	70.27	10.07	4,69	0.60	4.57	9,79

Table-10 indicates the results of different energy inputs in MJ/acre consumed in production of wheat. Thus result clearly shows that the most critical and extensive used energy input is Nitrogen which was calculated 5476.39, 5376.13 and 5955.02 MJ/acre respectively and result shows that in all types of farmers categories Nitrogen use of the large farmers were highest whereas, medium farmers were using low Nitrogen energy as compare to others. Energy used in from phosphorus was very low as compare to all other energy inputs and was calculated 416.92, 416.72 and 397.78 MJ/acre for small, medium and large farmers. Secondly the most important energy inputs that was calculated is seed energy which as calculated 873.60, 860.28 and 853.32 MJ/acre respectively. However result indicates that highest amount of energy f seed in form seed was consumed by large framers and lowest amount of seed energy was used by small farmers. Machine energy used by small, medium and large farmers is 363.66, 372.64 and 387.67 MJ/acre respectively highest amount of machine energy was used by small farmers. Other form of energy that was used n the production of wheat is labour energy which is the most important energy input as wheat is a labour intensive crop because harvesting is done by human labour, energy consumption pattern of human energy in wheat production was estimated at 51.30, 49.67 and 51.02 MJ/acre for small, medium and large farmers. Small farmers were using highest amount of human energy due to family and other type of energy that was used in production of wheat is diesel energy which is used to operate a machine for planking, ploughing, harvesting and irrigation. The amount of diesel energy used in production of wheat is 839.82, 828.01 and 829.54 MJ/acre and highest amount of energy was used by small farmers.

Direct and Indirect Energy (MJ/Acre) used in Production of Wheat

The table given below shows average direct and indirect energy used in production of wheat. Table clearly shows that energy used in production of wheat in from indirect was greater than that of energy used in direct form.

Table 11: Direct and Indirect Energy (MJ/acre) used in production of wheat

Farmers Category	Direct Energy (MJ/acre)	Indirect Energy (MJ/acre)	Total Energy
Small	891.11	7130.56	8021.69
Medium	877.68	7025.22	7902.91
Large	880.56	7593.78	8474.35

Table-11 indicates the average amount of direct energy used in production of wheat by small farmers was highest as they have their family labour and they heavily depend upon the human labour. In production of wheat small farmers used 891.11, MJ/acre direct energy which highest among all farmers group. Whereas, large and medium farmers used average direct energy 880.65 and 877.68 MJ/acre respectively in production of wheat. The average amount of indirect energy used in production of wheat by small farmers was highest as they have their family labour and they heavily depend upon the human labour. In production of wheat small farmers used 7130.56, MJ/acre indirect energy which highest among all farmers group. Whereas, large and medium farmers used average indirect energy 7593.78 and 7025.22 MJ/acre respectively in production of wheat.

Renewable and Non-renewable Energy (MJ/acre) used in Production of Wheat

Energy can be renewable and non-renewable. Renewable energies are human power, seed, manure etc. Non-renewable energies can include fuel, electricity, fertilizers, irrigation and farm machinery. The table given below clearly shows use of non-renewable energy was greater than that of renewable energy used in production of wheat.

Table 12: Renewable and Non-renewable Energy (MJ/acre) used in production of wheat

Farmers Category	Renewable Energy (MJ/acre)	Non-renewable Energy (MJ/acre)	Total Energy
Small	924.90	7096.79	8021.69
Medium	909.96	6992.95	7902.91
Large	904.34	7570.13	8474.35

Table-12 shows that the average per care renewable energy used in production of wheat. In production of wheat small farmers used 924.90, MJ/acre renewable energy which highest among all farmers group. Whereas, large and medium farmers used average renewable energy 904.34and 909.96 MJ/acre respectively in production of wheat. The average amount of non-renewable energy used in production of wheat by small farmers was highest as they have their family labour and they heavily depend upon the human labour. In production of wheat small farmers used 7096.79, MJ/acre non-renewable energy which highest among all farmers group. Whereas, Large and medium farmers used average non-renewable energy 7570.13 and 6992.95, MJ/acre respectively in production of wheat.

Net Energy Gain in Production of Wheat

The table which is given below indicate total energy used by small, medium, large farmers and calculated the net energy gained in production of wheat which was calculated by the given formula.

Net Energy Gained (Wheat) = Total Energy Returns (Outputs) –Total Energy Used (Inputs)

Table 13: Totals energy MJ/acre consumed and net energy (MJ/acre) gain in production of wheat

Farmers Category	Description	Wheat
Small Farmers	Energy Used	1368336.88
	Net Energy Gained	39095.33
Medium Farmers	Energy Used	1698003.79
	Net Energy Gained	38590.99
Large Farmers	Energy Used	1702527.75
	Net Energy Gained	41525.06

Table-13 shows total energy used by small, medium and large farmers in MJ/acre in production of wheat. The table showed that energy used in production of wheat by small, medium and large farmers is 1368336.88, 1698003.79 and1702527.75 MJ/acre respectively. Net energy gained which was calculated by the above mentioned formula and the results are given above which shows that there is a significant difference between energy used and net energy gained. In production of wheat large, medium and small farmers achieve amount of net energy which was calculated 41525.06, 38590.99, 39095.33 MJ/acre respectively.

Impact of different Energy inputs on yield of wheat

Table 14: Impact of different Energy inputs on yield of wheat

Category	Coefficients	Std. Error	T test	Significant
Constant	10.329	0.119	11.613	.000
Nitrogen Energy	0.017	0.037	0.468	.640
Seed Energy	0.138	0.117	1.171	.244
Phosphorus Energy	0.106	0.035	3.002	.003
Labour Energy	0.072	0.035	2.301	.023
Machine Energy	0.040	0.055	0.735	.464
Diesel Energy	0.119	0.046	2.587	.011

Table-14 shows that nitrogen energy with the value of coefficient 0.017 and standard error is insignificant at the level of 0.640, which shows that nitrogen energy does not play an important role in output energy production. Seed energy with the value of confection 0.138 and standard error 0.117 is insignificant at the level of 0.244 which shows the seed energy has not significant role in output energy production. Phosphorus energy with the value of coefficient 0.106 and standard error 0.035 is significant at the level of 0.003 that shows in output energy production phosphorus plays important role.

Labour hour energy is an important factor of production. It has coefficient value of 0.072 with standard error of 0.035 and significant at the level of 0.023. It shows that one percent increase in labour energy produce 0.072 percent output production. The machine hour's energy uses such as tractor, thresher etc does not have significant impact on output energy production. The coefficient of machine energy has a value of 0.040 with standard error of 0.055 but it is non-significant.

The diesel energy is most important factor of production. The value of coefficient for this variable energy is 0.119 with the standard error of 0.046 and significant at the level of 0.011. It shows that one percent increase in diesel energy may produce 0.119 percent higher in output energy.

Impact of different factors on energy use

Energy use is changed it depends upon the different socio-economic factor. Energy use will be increase if farmers field are near to the market from he can easily get input. Energy use has a positive impact if farmers have their own tractor and tube well it also depends upon the area owned by the farmers. Credit facilities also have positive impact on energy use. There are many other factors which have their impact on energy. On the other hand farmers experience will have negative impact on energy use as they use on required amount of inputs. Farmers age also have negative impact on the energy use. The given below shows some factors which have positive impact on energy use in production of wheat.

Table 15: Impact of different Energy inputs on yield of wheat

Category	Total Energy used	Land Holding	Tractor owned	Tube well owned	Irrigations
Small	8021.69	3.31	33	35	3.72
Medium	7902.19	9.1	44	44	4.3
Large	8474.35	18.7	43	41	5.58

Table-15 shows that total energy used by small farmers was 8021.69 MJ/acre the result indicates that they as using least amount of energy they have less amount of landholding very few have their own tractors and tube well. On the other hand large farmers using heist amount of energy they have their own tractors and tube well.

Discussion

The relationship between energy consumption and economic growth has important implications at the theoretical and policy level. A large number of studies have focused on the relationship between energy consumption and real output. (Azarpour, 2012) suggested that one way to evaluation of sustainable development in agriculture is using of energy flow method. This method in an agricultural system is the energy consuming in product operations and energy saving in product crops. In this article , evolution of energy balance and energy indices under watered farming wheat in north of Iran as investigate .data were collected from 72 farms by using a face to face questionnaire method during 2011 year in Guilan Province. By using of consumed data as inputs and total productions output, and their concern equivalent energy, energy balance and energy indices were calculated. Energy efficiency for seed and straw in this study were calculated to be 2.47 and 2.48, respectively, showing the affective use of energy in agro ecosystems wheat production. Energy balance efficiency for seed and straw in this study were calculated 1.50 and 1.29 respectively, showing the affective use of energy in the agro ecosystem wheat production.

However, to date the results e mixed and conflicting. The variation in empirical finding could be due to different economic structure of particular countries being studied (Sari *et al.* 2008)

Demand for the energy is increasing day by day due to industrial and infrastructure development, energy is required to perform all the human activities. It provides services for food preparation, water cooling and heating, for illumination, good health, for strong goods, for extraction for minerals, for production of industrial goods, for transportation and the most important is for the production of different crops. No country in modern world has managed to develop much beyond a subsistence economy without ensuring at least minimum access to energy services for its population. Throughout the world, energy resource available to them and their ability to pay largely determine the way in which people live their lives. The scientists are trying to find out the alternatives sources for energy as it is a non-renewable resource. Energy demand in agriculture sector has been significantly increased since last half century due to high use of energy inputs. Energy is required for manufacturing inputs like fertilizers and chemicals. Agriculture sector consumes different types of energies in different ways. These can be direct, indirect, renewable or non-renewable energies. Direct energy may include human power, animals, fuel, electricity, irrigation, whereas; indirect energy is acquire from fertilizers, pesticides, insecticides, herbicides and farm machinery etc. Renewable energy is human power, seed, manure etc. Non-renewable energies can include fuel, electricity, fertilizers, irrigation and farm machinery.

Energy is necessity of life for human beings all over the world due to its function in strengthening the security and contentment of the people. As population is increasing its day by day and to feed this increasing population farmers have to do extensive agricultural practices, To increase the yield, farmers used more fertilizers, farmers used new technologies which increasing energy use in agriculture. (Shahan *et al.* 2009) conducted a study and the results of this study indicated that total energy inputs were 47.08 GJ ha-1. About 31.19% was generated by chemical fertilizer, 26.05% from diesel oil and machinery. About 73.27% of the total energy inputs used in wheat production was in direct and 26.73% was direct. mean grain wheat yield was about 4514.8 kgha-1, it obtained under normal conditions on irrigated farming and taking into account the energy value of the seed, the net energy and energy productivity value was estimated to be 45.71 GJ ha-1 and 0.096 kg MJ-1 , respectively. The ratio of energy outputs to energy inputs was found to be 1.98. This indicated an intensive use of inputs in wheat production not accompanied by increase in the final product. Cost analysis revealed that total cost of production for one hectare of wheat production was 809.44$. Benefit-cost ratio was calculated as 1.43.

Due to these operations the cost of production becomes very high and farmers get lesser profit and net energy gained from agriculture is very low. To address these issue to find out the energy use in wheat production and its impact on crop yield, the study was carried out in the district Shaheed Benizarabad (Nawabshah) which is considered as an important district in wheat production in Sindh province. The study was focused on all types of energy.

Descriptive Statistics and Cobb-Douglas production function_was applied to analyze the data. Energy used in production of wheat by small, medium and large farmers was calculated 39095.33, 38590.99 and 41525.06 MJ/acre respectively. Energy used in production was highest of large farmers. His impact of various energy inputs on output was studied. The share of various energy types in total cost of production was estimated. The highest share in total energy was of commercial energy which diesel and electricity.

Conclusion

It was concluded that of majority of the respondents have sufficient wheat growing experience. Land holding in Sindh is very small. Majority of the farmers were cultivating their own lands. Energy is necessity of life for human beings all over the world due to its function in strengthening the security and contentment of the people. As population is increasing it's day by day and to feed this increasing population farmers have to do extensive agricultural practices, To increase the yield, farmers used more fertilizers, farmers used new technologies which increasing energy use in agriculture. Due to these operations the cost of production becomes very high and farmers get lesser profit and net energy gained from agriculture is very low. To address these issues to find out the energy use in wheat production and its impact on crop yield, the study was carried out in the district Shaheed Benizarabad (Nawabshah) which is considered as an important district in wheat production in Sindh province. In the light of the above conclusions the following recommendations were made:

- As the output of wheat crop is positively dependent on the human; chemicals and commercials energy applied, therefore more cultural practices and high levels of chemicals and commercials of energy sources should be applied.
- Wheat yield positional depends upon primarily on genetic factors, but its level of exploitation is significantly influenced by level and packages of the inputs applied. A proper level as well as economically advisable combinations of different energy types should be maintained
- Commercials energy had played a key role in raising the level of energy use. Credit facility for the purchase of tube well, tractors and other machineries is not sufficient to rise. So credit facility must be provided to the farmers on easy term and conditions at the door step.
- Government should be arranged agricultural machinery and other allied equipment properly.
- Chemicals sources of energy i.e. fertilizers, pesticides, herbicides are energy intensive inputs, but considerable quantity of this energy source is wasted.
- Government should be provided cheap rate fertilizers in form residuals.
- Proper measures should be adopted for the minimization of energy losses in agriculture.
- Optimum use of irrigation water can avoid leakage.
- Agricultural policy maker should give such type of alternative in which farmers can provided their own energy. Such as befoul plants should be given at subsidized rate so that farmers can produce energy.
- The farmers of our Sindh province are mostly un-educated and lack of new technical knowledge. So Government of Sind must be positive in the farmer's education.
- The majority of our farmers are very poor and they often live in a hand to mouth position. Most of them are always under heavy burdens of debts. Government must be financial support through the micro-finance and other sides.

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