Agriculture Footprint of Villages of Ellenabad sub-division of District Sirsa

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Abstract- Everything which looks Green is not always clean. Currently, Agriculture emits more greenhouse gases than all our cars, trucks, trains, and airplanes combined and are amongst the greatest contributors to global warming. This Study estimates the Footprint of Cultivation of Wheat Rice and Cotton cultivation in Villages of Ellenabad sub-division of District Sirsa. Greenhouse gas emissions from crops occur due to such activities as Soil preparation, Sowing, Disease and weed control, Nutrition for better yield, Harvesting, transport to market, and upon burning of straw/stubble. The methodology underlying the analysis of the Carbon Footprint of the Agriculture sector was based on the inputs, farm operations (soil preparation, sowing harvesting, transportation, residue burning, etc.), and the yield of the final product. The collected data was translated into CO_2 equivalent using conversion factors provided by various references. The benefit of this comprehensive study is prior information at hand, to plan agriculture programs, crop selections, farm practices, and selection of farm inputs in a manner that reduce adding up of greenhouse gases to the atmosphere.

I. Introduction

There is an overwhelming scientific consensus that the Earth's climate is changing as a consequence of human activity on the planet. (American Scientific societies, 2009). According to an ongoing temperature analysis conducted by scientists at NASA's Goddard Institute for Space Studies (GISS), the average global temperature on Earth has increased by about 0.8° Celsius (1.4° Fahrenheit) since 1880. The most important aspect of this change is that the average temperature of the Earth is rising, slowly but steadily, as a consequence of the emission of greenhouse gases (GHGs) and their increasing concentration in the atmosphere (*IPCC, 2007*). Of the greenhouse gases that contribute to global warming, carbon dioxide (CO_2) is by far the most significant (*IPCC, 2001a*).
Sustainable development and equity provide a basis for assessing climate policies and highlight the need for addressing the risks of climate change. Limiting the effects of climate change is necessary to achieve sustainable development and equity, including poverty eradication. *(IPCC, 2014: Summary for Policymakers. In: Climate Change 2014).*

Concept of Carbon footprint.

Carbon footprinting has potential as a tool for assessing and comparing GHG performances of different products along with identification of points to improve environmental efficiencies. (Aggarwal and Pandey, 2014). Carbon footprints originated as a subset of the ''ecological footprint'' proposed by Wackernagel and Rees (1996). Ecological footprint referred to the biologically productive land and sea area required to sustain a given human population, expressed as global hectares. According to this concept, carbon footprint was the land area that will assimilate the CO_2 produced during the lifetime of a person or total global population. Definitions of carbon footprints were different among different studies, and the term "carbon footprint" should reflect measure of the exclusive total amount of CO_2 emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product (Wiedmann and Minx, 2007). Another indicator, derived from Carbon Footprint is ''climate footprint,'' which was proposed to be used, if all the GHGs were included in the calculation instead of only CO_2 ,but keeping in mind the purpose of assessing the impact of the activity on global climate (*Kelly et al., 2009*).

Footprints are spatial indicators (Hammond, 2007 and Global Footprint Network, 2007) therefore the carbon footprint should precisely be called a ''carbon weight'' or ''carbon mass'' (Jarvis, 2007). However, convenient calculations and widespread acceptance makes CO_2e mass the practical unit of carbon footprints. The term ''carbon footprint'' has evolved as an important expression of greenhouse gas (GHG) intensity for diverse activities and products.

Agriculture as a Source of GHG Emissions

The 38 percent of total land used for agriculture is by far the largest use of land on the planet and much of the rest is unsuitable land for agriculture as it is covered by deserts, ice, mountains, tundra or cities (*Ellis et al., 2010*). Currently Agriculture emits more greenhouse gases than all our cars, trucks, trains, and airplanes combined is amongst the greatest contributors to global warming, mainly from methane released by cattle and rice farms, nitrous oxide from fertilized fields, and carbon dioxide from the cutting of rain forests to grow crops or raise livestock. (*Foley, J. 2014*)

The Green house gas emissions from Agriculture, Fisheries and forestry have almost doubled over the past fifty years and would further increase by 2050 to an additional 50% without any effort made to reduce them, the reason is that the population growth will require us to roughly double the amount of crops we grow by 2050. *(FAO's HOW2050, 2011)*

The World will likely have two billion more people to feed by midcentury—more than nine billion people. To double the growth the Land use and Inputs have to be increased as the same Area of Agriculture land and the same amount of inputs will not lead to greater production *(FAO, 2014)*

According to latest CGIAR (Consultative Group on International Agricultural Research)report the global food system, including fertilizer production to transportation, food storage and packaging is responsible for up to one-third of all human-caused greenhouse-gas emissions(Gilbert - Nature Journal, 2012). Agriculture accounted for an estimated emission of over 5.3 billion tonnes CO_2 equivalent in 2011, a 14 percent increase. The increase occurred mainly in developing countries, due to an expansion of total agricultural outputs. (FAO,2014). Despite large annual exchanges CO_2 between the atmosphere and agricultural lands, the net flux is estimated to be approximately balanced, with CO_2 emissions around 0.04 $GtCO_2$/yr only (emissions from electricity and fuel use are covered in the buildings and transport sector, respectively) *(IPCC 4th assessment report, 2007).*

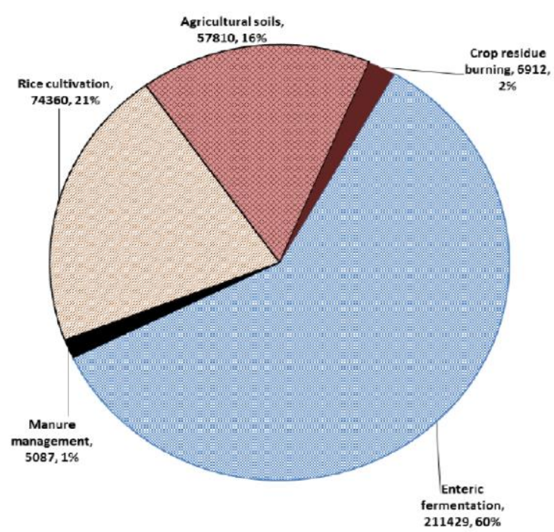

Figure – Contribution of Agriculture to GHG Emissions in India in 2007 (*MOEF, 2010*)

Need for Study

Haryana is an agrarian state, In Haryana, Sirsa is extensively into Agriculture. As there are no reported studies on Carbon Footprint from Agriculture sector in Sirsa district of Haryana, hence present study was taken up in one of the Tehsils. Sirsa has 4 Tehsils. Ellenabad is one of these. Ellenabad is on the forefront of Agriculture productions due to various factors such as Rich Soil, Good Source of Ground Water, Good Sources of Canal and River Water, Diverse Culture, Varied Agricultural practices in different villages. Hence Ellenabad was selected as Study area for estimation of Carbon foot print from Agriculture.

Carbon Footprint being a quantitative expression of GHG emissions from an activity helps in emission management and evaluation of mitigation measures *(Carbon trust, 2007b)*

Agriculture is one of the major contributors to anthropogenic emissions of Greenhouse gases, so the quantification of different agricultural practices is essential for identification of more sustainable practices. Carbon foot printing has potential as a tool for assessing and comparing GHG performances of different agricultural products along with identification of points to improve environmental efficiencies. *(Pandey and Madhoolika, 2011)*

II. Study Area

This study focuses on the cultivation of Wheat, Rice, Cotton (Bt. Cotton as well as Desi Cotton/the non hybrid in villages of Ellenabad Tehsil of district Sirsa, Haryana. This study considers emissions in regions well fed with river and canal water as well as the one which is solely dependent on pumping of ground water for irrigation. The pattern of crop cultivation is different for both the regions i.e. Wheat and Rice cultivation in well irrigated areas and Wheat and Cotton in the areas which are not served by River Ghaggar or Canals. Rice straw and wheat stubble is normally left in the fields after harvest, and most of it is burned.

Greenhouse gas emissions from crops occur due to such activities in agriculture sector: Soil preparation, Sowing, Disease and weed control, Nutrition for better yield, Harvesting, transport to market and upon burning straw/stubble.

Ellenabad Tehsil

Ellenabad is a Tehsil in the Sirsa District of Haryana. According to Census 2011 information the sub-district code of Ellenabad block is 00392. It has 30 villages.

Ellenabad is located between 29°34’ **:** 29°51’ North latitudes and 74°87’ **:** 75°55’ East longitudes. Geographical area of 546.96 Sq. Km (*Distt. Census Handbook Sirsa 2011*)

The present study was carried out in villages of Ellenabad Tehsil of District Sirsa. Farmers of these villages were randomly selected, after casual interaction, some specific questions related to their own farm practices were asked. The objective of the study was not just to determine the per acre, per crop, carbon footprint in Ellenabad Tehsil, but also to know the cropping pattern and farm practices adopted by farmers of the Ellenabad Tehsil. This Tehsil has a variety of cropping pattern especially in *Kharif* season; care was also taken to ask questions from farmers who had large land holdings as well as from small and marginal farmers.

List of Villages in Ellenabad Tehsil

1. Amritsar	2. Berwala Khurd	3. Bhurat Wala
4. Budhi Mari	5. Chilkani Dhab	6. Dhani Jatan
7. Dhol Palia	8. Ellenabad	9. Himayun Khera
10. Karamsana	11. Keshopura	12. Khari Surera
13. Kotli	14. Kumbhthal	15. Kuta Budh
16. Mamera	17. Mehna Khera	18. Mirzapur
19. Mithanpur	20. Mithi Surera	21. Moju Khera
22. Moosli	23. Neemla	24. Patti Kirpal
25. Phorka	26. Ratta Khera	27. Shekhu Khera
28. Talwara Khurd 1	29. Thobaria	30. Umedpura

Methodology Analysis

The methodology underlying the analysis of the Carbon Footprint of Agriculture sector was based on the inputs, farm operations (soil preparation, sowing harvesting, transportation, residue burning etc.) and the yield of the final product. These characteristics are further used to estimate the energy use and t he associated CO_2 emissions.

To obtain the objectives of the study, the study was divided into three parts:

- Survey
- Collection of data
- Estimation of GHGs.

Survey

A survey was conducted in 28 villages of Ellenabad Tehsil of District Sirsa. There are 30 villages in Ellenabad Tehsil.

The questionnaire consisted questions related to farm inputs, Fossil fuel consumption, electricity use and other related farm activities. Open ended questions were used so that the farmer can answer freely without any restriction. All the questions were asked to know the consumption of inputs (Diesel Fuel, Electricity for Tube-wells, Fertilizers, and Pesticides) per acre for each crop they grow.

Collection of Data
The basis for the calculation

- The previous year data.
- Amount of main product or the Crop yield.
- Amount and type of raw materials used (like green manure, brown Manure etc)
- Amount of Agro-chemicals used:

Amount of pesticides
Amount of Fertilizers

- Diesel Consumed
- Electricity Consumed

Data gathering from databases and literature
The following sources were used:
• Official statistical data from government bodies
• Scientifically peer-reviewed literature
• Emission factors of fertilizers (emissions from production plus field emissions), Pesticides, diesel used in agricultural machinery or for transport, Electricity consumed.

Estimation of embedded GHGs

The collected data was translated into CO_2 equivalent using conversion factors provided by various references. The unit of carbon footprint varies according to entity considerations. Carbon footprint was calculated on per crop season basis. Carbon footprint of various agricultural inputs was calculated in the following manner:

Emissions from Agrochemicals

To estimate the GHG emissions from Agrochemicals viz. Fertilizers and Pesticides (includes fungicides, herbicides insecticides etc.) The following methods were used:

For calculating the emissions from Fertilizers ($EM_{Fertilizers}$):

- *Step 1:* Determine the type fertilizer used
- *Step 2:* Determine the quantity of fertilizer used per acre
- *Step 3:* Calculate using the Formula below

$EM_{Fertilizers}$ = Fertilizer amount (Kg) * Emission Factor $_{Fertilizer\ (Production\ +\ use)}$
(ISCC 205)

Table 1 Fertilizers CO_2 emission coefficients for per Kg of product used

Fertilizer	Emission Factor	Ref.
Urea	1.118	IPCC, 2007
DAP	2.03	IPCC, 2007
Zinc Sulphate	1.9978	IPCC, 2007
NPK	1.61	IPCC, 2007

Calculating GHG emissions from Pesticides ($EM_{Pesticides}$)

- *Step 1*: Determine the type of Pesticide
- *Step 1*: Determine the quantity used
- *Step 1*: Calculate the GHG emissions from that pesticide using the formula

EM $_{Pesticides}$ = Input amount * Emission Factor Input (Production + use)
(ISCC 205)

Table 2 Farm Chemicals CO_2 emission coefficients for per Kg of product used

Type	Emission Factor	Source
Herbicides		
2,4-D	1.7	Lal, 2004
Butachlor	5.6	Lal, 2004
Glyphosate	9.1	Gaillard et al., 1997
Paraquat	9.2	Lal, 2004
Pretilachlor	5.5	Gaillard et al., 1997
Pendimethalin	1.1	Gaillard et al., 1997
Algrip Metsulfuron	21.14	
Leader Sulfosulfuron	2.91	Gaillard et al., 1997
Topik Clodinafop	.888	Lal, 2004
Fungicides		
Tebuconazole	1.68	Gaillard et al., 1997
Propiconazole	4.79	Nalley et al., 2012
Insecticides		
Cypermethrine	11.7	Lal, 2004
Lambda-cyhalothrine	7.02	Gaillard et al., 1997
Phorate (Thiamate)	4.2	Lal, 2004
Acephate	3.55	Green, 1987
Cartap	9.1	Lal, 2004
Chloropyriphos	15.37	Green, 1987
Imidacloprid	1.141	E. Audsley et al., 2009
Meothrin/Fenpropathrin	0.0017	Garthwaite et al., 2006
Actara - thiamethoxam	1.1	Lal, 2004
Polo/diafenthiuron	5.4	Lal, 2004
Regent	5.7	Lal, 2004
Acetamiprid	18	Gaillard et al., 1997
Triazophos	15.36	Gaillard et al., 1997
Carbryl	3.1	Lal, 2004

Emissions from Diesel
To estimate the GHG emissions from use of diesel as fuel in farm machinery, the following method was used:

Calculating the emissions by Diesel Consumption by farm machinery (EM $_{Diesel}$)

- *Step 1:* Determine the type and number of farm operations
- *Step 2:* Diesel used in each operation
- *Step 3:* Calculate emissions from Diesel consumption using the formula below:

EM $_{Diesel}$ = Diesel amount (L) * Emission Factor$_{Diesel\ (Production\ +\ use)}$ *(ISCC 205)*

Diesel consumed by Tractors, Combined Harvesters, levelers, cultivators was added to get a total of diesel consumption by farm machinery.
Emission factor diesel = 2.734 Kg CO_2/l (Emission Factor development for Indian Vehicles, Central Pollution control board, Government of India, August, 2007)

Emissions from Electricity

To estimate the GHG emissions from use of Electricity for Pumping ground water for Irrigation, the following Method was used:

Calculating GHG emissions from use of Electricity in pumping water ($EM_{Electricity}$)

- *Step 1*: Determine the Power of electric motor in a tube-well in hp
- *Step 2:* Determine the running time of motor in days and hours
- *Step 3:* Calculating the GHG emissions from pumping water using an electric motor by formula:

$EM_{Electricity}$ = Electricity (KWH) * Emission Factor Electricity
(ISCC 205)
(Emission Factor Electricity = 0.82 Kg CO_2 /KWh (CO_2 baseline database for the Indian Power sector, user guide, Version 5, November 2009. Emissions are considered at the power generation point only since estimations at the end use point depends on the number of variable factors. This also gives the most conservative estimation.
Formula used to convert to KWh:
Power of motor in hp * Running time (Running time in days and hours is converted as: no. of days * no. of Hours the motor runs each day)

To estimate the GHG emissions from use of diesel as fuel in farm machinery, the following formulae were used:
Calculating the total GHG emissions (EM) from cultivation ($EM_{Cultivation}$)

- *Step 1:* Determine emissions from each characteristic to cultivate a crop:

Emissions from Fertilizer
Emissions from pesticides
Emissions from Diesel consumption.
Emissions from Electricity use in pumping water

- *Step 2:* Determine Total yield of the crop
- *Step 3:* Calculate using the formula below:

$EM_{Cultivation} = EM_{Fertilizer} + EM_{Diesel} + EM_{Electricity} + EM_{pesticides}$ / Crop yield
(ISCC 205)

III. Results and Discussions

Agriculture is the systematic raising of useful plants and livestock under the management of man. (Rimando, 2004). The need for food poses one of the biggest dangers to the planet. Agriculture is among the greatest contributors to global warming, emitting more greenhouse gases than all the cars, trucks, trains, and airplanes combined. Agriculture is an avoidable source of Green house gases as we need food for survival. As the population grows the inputs in Agriculture will increase, leading to addition of Green house gases to the Planet and if the yield is not meeting the needs the effect would be greater as we will tend to grow more crops. For most of history, whenever we've needed to produce more food, we've simply cut down forests or ploughed grasslands to make more farms, consuming more water; farming is the thirstiest user of precious water supplies *(Foley, J. 2015).*

The overall goal of estimation of Agriculture's Carbon Footprint is to obtain a comprehensive picture of the contribution of Agriculture to Global warming. The benefit of this comprehensive study is prior information at hands, to plan agriculture programs, crop selections, farm practices, and selection of farm inputs in a manner which reduce adding up of the green house gases to the atmosphere.

The study carried out in the villages of Ellenabad Tehsil of District Sirsa, Haryana, provides information on the farm practices, the produce at these farms, and the related Green House Gas emissions. A survey of 28 farmers, each farmer from a different village of Tehsil Ellenabad was carried out. The variation in carbon foot print across different crops, different crop seasons was explored.

To attain the objective of the study the analysis of the carbon footprint of agriculture was based on the inputs, farm operations and the yield of the final product. These characteristics are further used to estimate the energy use and the associated CO_2 emissions.

CO_2 is emitted from on-farm and off-farm operations like use of machines, production of fertilizers and pesticides. Farm operations and off-farm practices such as production of fertilizers and biocides (*Pathak et al., 2012*)

GHG Emissions from use of Fertilizers

A fertilizer is any material of natural or synthetic origin that is applied to soils or to plant tissues to supply one or more plant nutrients essential to the growth of plants.

The use of fertilizers is very important in almost every crop to maintain soil fertility, improve crop development, yield and crop quality. Fertilizers are the chief source of plant nutrients. The use of fertilizers, especially mineral fertilizers had been a big catalyst in the happening of Green Revolution.

GHG emissions from agriculture originate mainly in the form of N_2O from fertilizer management practices (Le Mer and Roger 2001) Nitrogenous fertilizers are the source of N_2O in fertilized soils, whereas the indigenous N contributes to its release in unfertilized soil. (Pathak et al., 2012)

National GHG inventory guidelines provide average and default emission factors for production of fertilizers, GHG emissions from soil under different irrigation, and manure applications etc. In most of the studies, tier3 emissions, particularly of fertilizer application alone, contributed from 45 to 85 % of the total yield scaled carbon footprints (Gan et al. 2011a, b, 2012), whereas changes in soil carbon could turn the carbon footprints of wheat cultivation negative *(Pathak et al., 2012)* .

In villages of Ellenabad Tehsil emissions from Nitrogenous fertilizers (Urea and DAP) in wheat ranged from 81 to 190 Kg CO_2/acre (Table 4.4.1). In rice crop emissions from fertilizers were ranged from 40.6 – 167.7 Kg CO_2/Acre (Table 4.1.2). Cotton contributed in the range 50.75 - 139.75Kg CO_2/Acre

Table 3 GHG emissions from fertilizers used in Wheat

Village	Quantity Urea	Footprint	Quantity DAP	Footprint	Quantity Zinc	Footprint	Total
Amritsar	150	167.7	50	122.98	10	19.978	310.66
Beharwala	150	167.7	40	81.2	-	-	248.9
Bhuratwala	150	167.7	50	122.98	-	-	290.68
Budhimari	125	139.75	50	122.98	20	39.96	302.69
Dhol Palia	100	111.8	40	81.2	-	-	193
Ellenabad	125	139.75	40	81.2	10	19.978	240.93
Himayunkhera	110	122.98	40	81.2	10	19.978	224.16
Karamsana	125	139.75	40	81.2	-	-	220.95
Kesupura	150	167.7	50	122.98	-	-	290.68
Khari Surera	125	139.75	40	81.2	-	-	224.16
Kotli	150	167.7	50	122.98	10	19.978	310.66
Kumbthala	125	139.75	50	122.98	-	-	290.68
Kutabudh	150	167.7	50	122.98	-	-	290.68
Mamera	125	139.75	40	81.2	10	19.978	240.93
MehnaKhera	150	167.7	50	122.98	-	-	290.68
Mirzapur	125	139.75	40	81.2	10	19.978	224.16
Mithanpura	150	167.7	50	122.98	-	-	290.68
MithiSurerea	150	167.7	50	122.98	-	-	290.68
Moujukhera	150	167.7	60	124.4	15	29.967	322.07
Moosli	125	139.75	40	81.2	10	19.978	224.16
Neemla	125	139.75	-	-	5	9.89	149.64
PattiKirpal	120	134.56	50	122.98	-	-	257.54
Pohrka	110	122.98	40	81.2	-	-	204.18
Rattakhera	150	167.7	50	122.98	-	-	290.68
Sheikhukhera	170	190.06	50	122.98	10	19.978	333.02
Talwara Khurd	150	167.7	50	122.98	-	-	290.68
Thobria	125	139.75	40	81.2	10	19.978	240.93
Umedpura	110	122.98	40	81.2	-	-	204.18
Averages	134.64	150.55	45.93	104.46	10.83		
Maxima	170	167.7	60	124.4	20		—
Minima	125	111.8	40	81.2	5		

Table 4 GHG emissions from fertilizers used in Rice

Village	Qty Urea (kg)	Footprint $KgCO_2e$	Qty DAP (kg)	Footprint $KgCO_2e$	Qty Zinc (kg)	Footprint $KgCO_2e$	Qty Zinc + Urea (kg)	Footprint $KgCO_2e$	Total
Amritsar	150	167.7	50	101.5	-	-			269.2
Budhimari	125	139.75	50	101.5					241.25
Ellenabad	125	139.75	20	40.6			1+ 5	7.59	187.94
Himayunkhera	125	139.75	25	50.75					188.5
Kotli	100	111.8	50	101.5					213.3
Kutabudh	170	111.8			10	19.978			131.78
Mamera	125	139.75	20	40.6			1+5	7.59	187.94
Mirzapur	125	139.75	20	40.6			1+5	7.59	187.94
Moujukhera	150	167.7	30	60.9	10	19.978			248.58
Pattikirpal	150	167.7	25	50.75	10	19.978			238.43
Rattakhera	150	167.7	-	-	-	-			167.7
Sheikhukhera	150	167.7	-	-	-	-			167.7
Talwarakhurd	150	167.7	25	50.75	10	19.978			238.43
Thobria	125	139.75	20	40.6	10	19.978			200.33
Average	137.14	147.74	30.45	61.82	10	19.978	1+5	7.59	
Maxima	170	167.7	50	101.5	10	19.978	1+5	7.59	
Minima	125	111.8	20	40.6	10	19.978	1+5	7.59	

Table 5 GHG emissions from fertilizers used in Cotton

Village	Quantity Urea	Footprint $KgCO_2e$	Quantity DAP	Footprint $KGCO_2e$	Quantity Zinc	Footprint $KGCO_2e$	Quantity NPK	Footprint $KGCO_2e$	Total
Beharwala	125	139.75	25	50.75	-	-			190.5
Bhuratwala	50	55.9	25	50.75	-	-			106.65
Dhol palia	50	55.9	25	50.75	-	-			106.65
Karamsana	50	55.9	25	50.75					106.65
Kesupura	125	139.75	30	60.9	-	-	8	12.88	213.53
Kharisurera	50	55.9	25	50.75	-	-			106.65
Kumbthala	100	111.8	50	101.5	-	-			213.3
Mehnakhera	50	55.9	25	50.75	-	-			106.55
Mithanpura	125	139.75	30	60.9	-	-	8	12.88	213.53
Mithisurera	125	139.75	30	60.9	-	-	8	12.88	213.53
Moosli	130	145.34	27	54.81	10	19.978	8	12.88	233
Neemla	75	83.85	25	50.75					134.3
Pohrka	100	111.8	30	60.9	-	-			172.7
Umedpura	100	111.8	30	60.9	-	-			172.7
Average	89.64	100.28	28.71	58.29	10	19.978	8	12.88	
Maxima	130	145.34	50	101.5	10	19.978	8	12.88	
Minima	50	55.9	25	50.75	10	19.978	8	12.88	

Pesticides

Pesticides, Fungicides and Herbicides (aka Weedicides) is another set of important and widely used farm input apart from Fertilizers. Pesticides and subclass Fungicides and Herbicides are clubbed together in this study, as the primary role of these three components is plant protection.

Pesticides are substances meant for attracting, seducing, and then destroying, or mitigating any pest. They are a class of biocide. The most common use of pesticides is as plant protection products (also known as crop protection products), which in general protect plants from damaging influences such as weeds, plant diseases or insects. This use of pesticides is so common that the term pesticide is often treated as synonymous with plant protection product, although it is in fact a broader term, as pesticides are also used for non-agricultural purposes. The term pesticide includes all of the following: herbicide, insecticide, insect growth regulator, nematicide, termiticide, molluscicide, piscicide, avicide, rodenticide, predacide, bactericide, insect repellent, animal repellent, antimicrobial, fungicide, disinfectant (antimicrobial), and sanitizer.

Although pesticides have benefits, but manufacturing and use of most of these also contribute to Green House Gases.

Fungicides are biocidal chemical compounds or biological organisms used to kill or inhibit fungi or fungal spores. Fungi can cause serious damage in agriculture, resulting in critical losses of yield, quality, and profit. Fungicides can either be contact, translaminar or systemic.

Herbicides, also commonly known as weedkillers or weedicides, are pesticides used to kill unwanted plants. Selective herbicides kill specific targets, while leaving the desired crop relatively unharmed. Non-selective kill all kind of plants.

Pesticide manufacturing represents about 9% of the energy use of arable crops. Pesticide manufacturing represent about 3% of the 100-year Global Warming Potential (GWP) from crops *(E. Audsley et al., 2009)* The most well established source of information on pesticide manufacturing energy is "*Green*" (1987) Process energy is the energy required in the manufacturing process to produce the chemicals such as heating, creating pressure and cooling, plus the energy needed to create and transmit that energy to the manufacturing process.

Table 6 Herbicides in Wheat

	Clodinafop		**Metsulfuron**		**Sulfosulfuron**		**2,4 D Ester**		**Total**
Village	Qty. (g)	C Footprint $KgCO_2e$	Qty. (g)	C Footprint $KgCO_2e$	Qty.(g)	**C** Footprint $KgCO_2e$	Qty (ml)	C Footprint $KgCO_2e$	$KgCO_2e$
Amritsar	160	0.142	10	0.211	-	-	-	-	0.353
Beharwala	-	-	8	0.169	13	0.002	-	-	0.171
Bhuratwala	160	0.142	8	0.169	-	-	-	-	0.311
Budhimari	160	0.142	10	0.211	-	-	-	-	0.353
Dhol Palia	160	0.142	8	0.169	-	-	-	-	0.311
Ellenabad	160	0.142	8	0.169	-	-	-	-	0.311
Himayunkhera	160	0.142	-	-	-	-	-	-	0.142
Karamsana	-	-	8	0.169	16	0.047	-	-	0.216
Kesupura	160	.142	-	-	-	-	-	-	0.142
Khari Surera	160	0.142	10	0.211	-	-	-	-	0.353
Kotli	160	0.142	8	0.169	-	-	-	-	0.311
Kumbthala	160	0.142	-	-	-		-	-	0.142
Kutabudh	160	0.142	-	-	-	-	250	0.425	0.567
Mamera	160	0.142	8	0.169	-	-	-	-	0.311
MehnaKhera	160	0.142	8	0.169	-	-	-	-	0.311
Mirzapur	160	0.142	8	0.169	-	-	-	-	0.311
Mithanpura	-	-	8	0.169	16	0.047	-	-	0.216
MithiSurerea	-	-	8	0.169	16	0.047	-	-	0.216
Moujukhera	160	0.142	8	0.169	-	-	-	-	0.311
Moosli	160	0.142	8	0.169	-	-	-	-	0.311
Neemla	160	0.142	-	-	-	-	-	-	0.142

PattiKirpal	160	0.142	8	0.169	-	-	-	-	0.311
Pohrka	-	-	8	0.169	16	0.047	-	-	0.216
Rattakhera	160	0.142	-	-	-	-	-	-	0.142
Sheikhukhera	-	0.14	-	0.17	-	-	-	0.43	0.74
Talwara Khurd	160	0.142	8	0.169	-	-	-	-	0.311
Thobria	160	0.142	-	-	-	-	-	-	0.142
Umedpura	160	0.142	8	0.169	-	-	-	-	0.311
Average									0.285
Maxima									0.311
Minima									0.142

Table 7 Insecticide in Wheat

	Meothrin		**Cypermethrin**		**Chlorpyrifos**		**Thiamethoxam**		**Imidacloprid**		**Total**
Village	Qty (ml)	**C**Footprint $KgCO_2e$	Qty	**C**Footprint $KgCO_2e$	Qty (ml)	**C**Footprint $KgCO_2e$	Qty (g)	**C**Footprint $KgCO_2e$	Qty (ml)	**C**Footprint $KgCO_2e$	
Amritsar	-	-	-	-	1000	15.37	-	-	80	0.09	15.46
Beharwala	-	-	-	-	-		40	0.044	-		0.044
Bhuratwala	-	-	-	-	-	-	-	-	100	0.11	0.11
Budhimari	250	0.43	-	-	-	-	-	-	60	0.07	0.5
Dhol Palia	-	-	-	-	-	-	-	-	-	-	
Ellenabad	-	-	-	-	800	12.3	-	-	100	0.11	12.41
Himayunkhera	-	-	200	2.34	-	-	-	-	100	0.11	2.45
Karamsana	-	-	200	2.34	-	-	40	0.044	-	-	2.384
Kesupura	-	-	-	-	600	9.23	40	0.044	-	-	9.274
Khari Surera	-	-	-	-	1000	15.37	-	-	80	0.08	15.45
Kotli	-	-	200	2.34	-	-	-	-	100	0.11	2.45
Kumbthala	-	-	200	2.34	-	-	-	-	100	0.11	2.45
Kutabudh	200	0.34	-	-	-	-	-	-	-	-	0.34
Mamera	-	-	-		-	-	-	-	-	-	-
MehnaKhera		-	-	-	-	-	-	-	100	0.11	0.11
Mirzapur		-	-	-	-	-	-	-	-	-	-
Mithanpura	-	-	-	-	-	-	40	0.044	-	-	0.044
MithiSurerea	-	-	200	2.34	-	-	40	0.044	-	-	2.384
Moujukhera	-	-	-	-	-	-	-	-	-	-	-
Moosli	-	-	-	-	-	-	-	-	-	-	-

Neemla	-	-	100	1.17	-	-	-	-	100	0.11	1.28
PattiKirpal	200	0.34			-	-	-	-	60	0.06	0.4
Pohrka	-	-	200	2.34	-	-	-	-	100	0.11	2.45
Rattakhera	-	-	600	2.34	600	9.23	-	-	100	0.11	11.68
Sheikhukhera	-	-	-	-	-	-	-	-	100	0.11	0.11
Talwara Khurd	250	0.43	-	-	-	-	-	-	-		0.43
Thobria	250	0.43	-	-	-	-	-	-	60	0.07	0.5
Umedpura		-	200	2.34	-	-	-	-	100	0.11	2.45
Average											3.70
Maxima											15.46
Minima											0.11

Table 8 Fungicide in Wheat

	Propiconazole		**Tebuconazole**		**Total**
Village	Qty. (ml)	C Footprint $KgCO_2e$	Qty. (g)	C Footprint $KgCO_2e$	$KgCO_2e$
Amritsar	200	2.11	40	0.10	2.21
Beharwala		-	40	0.10	0.10
Bhuratwala	250	2.64	40	0.10	2.74
Budhimari	250	2.64	40	0.10	2.74
Dhol Palia	200	2.11	40	0.10	2.21
Ellenabad	300	3.17	40	0.10	3.27
Himayunkhera		-		-	
Karamsana	250	2.64	40	0.10	2.74
Kesupura	200	2.11	40	0.10	2.21
Khari Surera	200	2.11		-	2.11
Kotli		-	40	0.10	0.10
Kumbthala		-		-	
Kutabudh	300	3.165	40	0.10	3.175
Mamera	200	2.11	40	0.10	2.21
MehnaKhera	250	2.64	40	0.10	2.74
Mirzapur	200	2.11	40	0.10	2.21
Mithanpura	250	2.64	40	0.10	2.74
MithiSurerea	250	2.64	40	0.10	2.74
Moujukhera	200	2.11	40	0.10	2.21
Moosli	200	2.11	40	0.10	2.21
Neemla		-		-	
PattiKirpal	250	2.64	40	0.10	2.74
Pohrka	200	2.11	40	0.10	2.21
Rattakhera	300	3.17	40	0.10	3.27
Sheikhukhera		2.11	40	0.10	2.21
Talwara Khurd	250	2.64	40	0.10	2.74
Thobria	250	2.64	40	0.10	2.74
Umedpura	200	2.11		0.10	2.21
Average					2.51
Maxima					3.27

Minima					0.10

Table 9 Herbicides in Rice

	Pretilachlor		**Metsulfuron**		**Butachlor**		**Total**
Village	Qty. (ml)	C Footprint $KgCO_2e$	Qty. (g)	C Footprint $KgCO_2e$	Qty. (ml)	C Footprint $KgCO_2e$	$KgCO_2e$
Amritsar	500	2.8	30	0.25	-	-	3.05
Budhi Mari	500	2.8	30	0.25	-	-	3.05
Ellenabad	500	2.8	8	0.68	-	-	3.48
Himayunkhera	-	-	24	0.20	1000	5.7	5.9
Kotli	500	2.8	30	0.25	-	-	3.05
Kuta Budh	600	3.3	-	-	-	-	3.3
Mamera	500	2.8	8	0.68	-	-	
Mirzapur	500	2.8	8	0.68	-	-	
Mouju Khera	600	3.36	30	0.25	-	-	3.61
Patti Kirpal	-	-	30	0.25	1200	6.84	7.09
Ratta Khera	500	2.8	16	1.36	-	-	
Sheikhu Khera	500	2.8	30	0.25	-	-	3.05
Talwara Khurd	500	2.8	16	1.36	-	-	
Thobria	500	2.8	8	0.68	-	-	
Average							3.95
Maxima							7.09
Minima							3.05

Table 10 Insecticides in Rice

	Cartap		**Acephate**		**Imidacloprid**		**Thiamate**		**Chlorpyrifos + Cypermethrin**		**Chlorpyrifos**		**Total**
Village	**Oty (Kg)**	C Footprint $KgCO_2e$	**Qty (g)**	C Footprint $KgCO_2e$	**Qty.(g)**	C Footprint $KgCO_2e$	**Qty (Kg)**	C Footprint $KgCO_2e$	**Qty (ml)**	C Footprint $KgCO_2e$	**Qty (ml)**	C Footprint $KgCO_2e$	$KgCO_2e$
Amritsar	7	63.7	500	3.55	100	0.11	-	-	-				67.36
Budhi Mari	7	63.7	-	-	80	0.09	-	-	-				63.79
Ellenabad	7	63.7	-	-	-	-	-	-	-				63.7
Himayukhera	-	-	-	-	-	-	10	42	-				42
Kotli	7	63.7	500	3.55	100	0.11	-	-	-				63.81
Kuta Budh	10	91.0	400	2.84	60	0.06	-	-	-				93.9
Mamera	7	63.7	-	-	-	-	-	-	-				63.7
Mirzapur	7	63.7	-	-	-	-	-	-	-				63.7
MoujuKhera	7	63.7	500	3.55	-	-	-	-	500	7.690			74.94

Patti Kirpal	7	63.7	500	3.55	-	-	-	-	-		600	0.30	67.55
Ratta Khera	8	72.8	500	3.55	-	-	-	-	-				76.35
Sheikhu Khera	7	63.7	500	3.55	100	0.11	-	-	-				67.36
Talwara	10	91	-	-	80	0.09	-	-	500	7.690			98.78
Thobria	7	63.7	-	-	-	-	-	-	-				63.7
Average	-	-	-	-	-	-	-	-	-	-	-	-	69.33
Maxima													98.78
Minima													63.7

Table 11 Fungicide in Rice

	Propiconazole		**Total**
Village	**Qty. (ml)**	**C Footprint KgCO$_2$**	KgCO$_2$e
Amritsar	200	2.11	2.11
Budhi Mari	250	2.63	2.63
Ellenabad	-	-	-
Himayunkhera	300	3.16	3.16
Kotli	200	2.11	2.11
Kuta Budh	300	3.16	3.16
Mamera	-	-	-
Mirzapur	-	-	-
Mouju Khera	200	2.11	2.11
Patti Kirpal	200	2.11	2.11
Ratta Khera	200	2.11	2.11
Sheikhu Khera	-	-	-
Talwara Khurd	-	-	-
Thobria	-	-	-
Average	-	-	2.44
Maxima	-	-	3.16
Minima	-	-	2.11

GHG Emissions from Electricity used for pumping Ground water

The two primary sources of energy for ground water pumping are electricity and diesel (Malik R, 2009) In Farm operations ground water is mostly pumped using a tube-well that runs on electricity. This leads to CO_2 emissions. GHG emissions from irrigation water pumped by tube-well for Wheat crop was in the range 3670 - 6606 Kg CO_2e/acre. Emissions from Rice were in the range 3915 - 14681 Kg CO_2e/acre. Emissions from *Bt.* Cotton crop were in the range 3915 - 7830 Kg CO_2e/acre (Table 7**)**

Table 12 GHG Emissions from Electricity used for pumping Ground water

Village	POWER (HP)	Running Time (days)	WHEAT Footprint ($KgCO_2e$)	Running Time (days)	RICE Footprint ($KgCO_2e$)	Running Time(days)	COTTON Footprint ($KgCO_2e$)
Amritsar	25	40	4893.76	100	12234.4	-	-
Beharwala	20	60	5872.512	-	-	40	3915.01
Bhuratwala	25	40	4893.76	-	-	55	6728.92
Budhimari	25	40	4893.76	100	12234.4	-	-
Dhol Palia	20	60	5872.512	-	-	70	6851.264
Ellenabad	25	50	6117.2	120	14681.28	-	
Himayunkhera	25	40	4893.76	90	11010.96	-	
Karamsana	20	60	5872.512	-	-	55	5383.136
Kesupura	25	50	6117.2	-	-	60	7340.64
Khari Surera	25	40	3670.32	-	7340.64	30	
Kotli	20	30	5872.512	60	-	-	6851.264
Kumbthala	25	40	4893.76	-	-	60	7340.64
Kutabudh	20	40	3915.01	40	3915.01	-	
Mamera	25	60	7340.64	100	12234.4	-	
MehnaKhera	20	60	5872.51	-	-	60	5872.51
Mirzapur	30	45	6606.58	100	14681.28	-	
Mithanpura	25	45	5505.48	-	-	50	6117.2
MithiSurerea	20	40	3915.01	-	-	45	4404.38
Moujukhera	30	40	5872.51	50	7340.64	-	
Moosli	25	40	4893.76			45	5505.48
Neemla	20	50	4893.76			60	5872.51
PattiKirpal	27	40	5285.26	60	7927.89	-	
Pohrka	20	50	45893.76	-	-	75	7340.64
Rattakhera	25	40	4893.76	60	7340.64	-	
Sheikhukhera	25	40	4893.76	90	11010.96	-	
Talwara Khurd	25	40	4893.76	120	14681.28	-	
Thobria	30	40	5872.52	100	14681.28		
Umedpura	20	60	5872.52	-	-	80	7830.02
Average			6795.86		10808.22		6239.54
Maxima			7340.64		14681.28		7340.64
Minima			3670.32		3915.01		3915.01

GHG emissions from use of Diesel consumed by Farm Machinery

Machinery and equipment used in various farm operations like soil preparation, sowing, spraying of pesticides, harvesting and transport of the crop to the market is powered by Diesel as fuel. CO_2 Emissions from the use of diesel in this region ranged from 54.68 - 76.55 Kg CO_2 in Wheat, 60.15 - 73.82 Kg CO_2 from rice and 49.21 - 73.82 Kg CO_2 from Cotton crop.

Table 13 GHG emissions from Diesel consumption in farm operations in CO_2 eq.

Village	Diesel in Wheat (L)	Footprint ($KgCo_2e$)	Diesel RICE(L)	Footprint ($KgCO_2e$)	Diesel in Cotton (L)	Footprint ($KgCO_2e$)
Amritsar	28	76.55	27	73.82		
Beharwala	24	65.62			26	71.084
Bhuratwala	27	73.82			27	73.818
Budhimari	25	68.35	25	68.35		
Dhol Palia	18	49.21			18	49.212
Ellenabad	25	68.35	25	68.35		
Himayunkhera	24	65.62	24	65.62		
Karamsana	20	54.68			22	60.148

Kesupura	23	62.88			23	62.882
Khari Surera	20	54.68			20	54.68
Kotli	27	73.82	22	60.15		
Kumbthala	25	68.35			25	68.35
Kutabudh	25	68.35	25	68.35	-	-
Mamera	23	62.88	23	62.88		
MehnaKhera	24	65.62			26	71.084
Mirzapur	23	62.88	25	68.35		
Mithanpura	25	68.35			25	68.35
MithiSurerea	27	73.82			25	68.35
Moujukhera	23	62.88	25	68.35		
Moosli	22	60.15			26	71.084
Neemla	22	60.15	-	-	18	49.212
PattiKirpal	22	60.15	23	62.88	-	-
Pohrka	20	54.68			20	54.68
Rattakhera	22	60.15	23	62.88	-	-
Sheikhukhera	25	68.35	20	54.68		
Talwara Khurd	20	54.68	20	54.68	-	-
Thobria	25	68.35	25	68.35	10	27.34
Umedpura	21	57.41			27	73.82
Average	23.4	63.96	**23.7**	64.84	16.8	61.60
Maxima	18	49.21	**27**	73.82	27	73.82
Minima	28	76.55	**20**	54.68	10	27.34

GHG emissions from Cultivation of crops

In a general context, in agriculture, cultivation means tillage, this refers to any of the kinds of soil agitation. But in this study it also includes all the farm operations that need use of men and machinery, for different mechanical actions on soil before and after sowing, on plants, on harvesting, such as tractor driven ploughs, disk harrows, Rotavators, levellers, Ridgers, Mulchers, puddling for preparation of rice paddies, tillage in standing crop to remove weeds, harvesting by use of combined harvesters reaper, thrashers, reapers, power sprayers, planters, seed drills etc. and transportation to the nearest market mostly using a tractors that draws a trolley. These all factors are summed up and are divided by the yield to find out emissions from cultivations. Emissions from cultivation of wheat were in the range 1.86 - 4.86 KgCO_2/Acre. (Table 9**)** Emissions from Rice cultivation were in the range 1.50 - 6.82 KgCO_2/Acre. (Table 10**)**Emissions from Cotton (*Bt.* Cotton and Desi Cotton) cultivation were in the range 5.82–15.59KgCO_2/Acre.

Table 14 GHG Emissions from Cultivation of Wheat

Table 15 GHG Emissions from Cultivation of Rice Crop

Village	Farm Chemicals ($KgCO_2e$)	Fertilizers ($KgCO_2e$)	Diesel ($KgCO_2e$)	Electricity ($KgCO_2e$)	Yield (Kg)	Cultivation ($KgCO_2e$)
Amritsar	18.03	310.66	76.55	4893.76	2200	2.41
Beharwala	0.32	248.9	65.62	5872.51	1600	3.87
Bhuratwala	3.16	290.68	73.82	4893.76	2200	4.78
Budhimari	3.59	302.69	68.35	4893.76	2300	2.29
Dhol Palia	2.52	193	49.21	5872.51	1400	4.37
Ellenabad	15.99	240.93	68.35	6117.2	2100	3.07
Himayunkhera	2.59	224.16	65.62	4893.76	2200	2.36
Karamsana	5.34	220.95	54.68	5872.51	1600	3.85
Kesupura	11.63	290.68	62.88	6117.2	2000	3.24
Khari Surera	17.91	224.16	54.68	3670.32	1550	2.56
Kotli	2.86	310.66	73.82	5872.51	2500	2.50
Kumbthala	2.59	290.68	68.35	4893.76	2100	2.50
Kutabudh	4.17	290.68	68.35	3915.01	2000	2.14
Mamera	2.52	240.93	62.88	7340.64	2100	3.64
MehnaKhera	3.16	290.68	65.62	5872.51	1800	3.46
Mirzapur	2.52	224.16	62.88	6606.58	2400	2.87
Mithanpura	2.99	290.68	68.35	5505.48	2200	2.67
MithiSurerea	5.33	290.68	73.82	3915.01	2300	1.86
Moujukhera	2.52	322.07	62.88	5872.51	2500	2.50
Moosli	2.52	224.16	60.15	4893.76	2300	2.25
Neemla	1.42	149.64	60.15	4893.76	1800	2.84
PattiKirpal	3.45	257.54	60.15	5285.26	2500	2.24
Pohrka	4.88	204.18	54.68	4589.76	1900	2.55
Rattakhera	15.09	290.68	60.15	4893.76	2500	2.10
Sheikhukhera	3.06	333.02	68.35	4893.76	2400	2.21
Talwara Khurd	3.48	290.68	54.68	4893.76	2350	2.23
Thobria	3.38	240.93	68.35	5872.52	2000	3.09
Umedpura	4.97	204.18	57.41	5872.52	2000	3.07
Average						2.84
Maxima						4.78
Minima						1.86

Villages	Farm Chemicals ($KgCO_2e$)	Fertilizers ($KgCO_2e$)	Diesel ($KgCO_2e$)	Electricity ($KgCO_2e$)	Yield (Kg)	Cultivation ($KgCO_2e$)
Amritsar	72.52	269.2	73.82	12234.4	2700	4.66
Budhi Mari	69.47	241.25	68.35	12234.4	2600	4.85
Ellenabad	67.18	187.94	68.35	14681.28	2450	6.12
Himayun Khera	51.06	188.5	65.62	11010.96	2600	4.35
Kotli	72.52	213.3	60.15	7340.64	2500	3.07
Kuta Budh	100.36	131.78	68.35	3915.01	2800	1.50
Mamera	74.5	187.94	62.88	12234.4	2700	4.65
Mirzapur	74.5	187.94	68.35	14681.28	2600	5.77
Mouju Khera	80.66	248.58	68.35	7340.64	2800	2.76
Patti Kirpal	76.75	238.43	62.88	7927.89	2700	3.07
Ratta Khera	97.26	167.7	62.88	7340.64	2700	2.84
Sheikhu Khera	70.41	167.7	54.68	11010.96	2600	4.35
Talwara Khurd	117.58	238.43	54.68	14681.28	2400	6.29
Thobria	74.5	200.33	68.35	14681.28	2200	6.82
Average						3.59
Maxima						6.82
Minima						1.50

Table 16 GHG Emissions from Cultivation of Cotton Crop

Villages	Farm Chemicals ($KgCO_2e$)	Fertilizers ($KgCO_2e$)	Diesel ($KgCO_2e$)	Electricity ($KgCO_2e$)	Yield (Kg)	Cultivation ($KgCO_2e$)
Beharwala Khurd	13.49	190.5	71.08	3915.01	450	9.31
Bhuratwala	8.47	106.65	73.81	6728.92	900	7.69
Karmsana	27.38	81.28	60.15	5383.14	450	12.34
Kesopura	10.29	213.53	62.88	7340.64	1100	6.93
Khari Surera	12.81	106.65	54.68	6851.26	700	10.06
Kumbhthala	2.33	213.3	68.35	7340.64	1200	6.35
Dholpalia	32.48	81.28	49.21	6851.26	450	15.59
Mehna Khera	8.47	106.55	71.08	5872.51	900	6.73
Mithanpur	10.29	213.53	68.35	6117.2	800	8.01
Mithi Surera	10.29	213.53	68.35	4404.38	500	9.39
Moosli	13.44	233	71.08	5505.48	1000	5.82
Neemla	20.87	109.23	49.21	5872.51	400	15.13
Pohraka	6.89	172.7	54.68	7340.64	1150	6.59
Umedpura	6.89	172.7	73.82	7830.02	1100	7.35
Average						9.09
Maxima						15.59
Minima						5.82

IV. CONCLUSION

On the basis of the findings of this study, following conclusions were drawn.

There are broadly two types of crop rotations. One is Wheat-Rice, chiefly in areas that are fed by Ghaggar Water Services that carries flood water, Bhakra Canal System, and tube-wells, these areas have good irrigation facilities; and the other is Wheat-Cotton, chiefly in areas where there is deficiency of irrigation facilities.

Wheat is grown under aerobic conditions; therefore soil emission of CH_4 is zero. From cultivation of wheat the emissions were found to be in the range 1.86 ~4.78 gCO_2e.Emission of N_2O-N from soils due to fertilizer application, the highest contributor other than electricity is Fertilizer with average footprint as: 81.2~167.7 $KgCO_2e$. (Electricity is a high contributor, especially the part of electricity that is generated by thermal projects) but it is a common factor amongst all the crops).

In rice cultivation the emissions were found to be in the range 1.50~6.82 $KgCO_2e$.Soil is the major contributor of methane as Rice is grown in flooded fields (Paddy). In this region Rice cultivation is mostly by Transplantation of Rice plants grown in a nursery (TPR) which contributes to more GHG emissions due to continuous flooding of Rice fields. The Direct seeded Rice (DSR) has comparatively lesser emissions in comparison to the TPR method, (Pathak et. al, 2009), but this method (DSR) has not been adopted by rice growers of the study area yet.

Cotton emissions were found to be in the range 5.82 ~15.59 $KgCO_2e$.There are no emissions from residue burning in Cotton crop, as cotton sticks are never burnt on the field and are either used as fire wood for cooking in villages or sold to wood and other industries. Yield is an important factor/divisor in the overall footprint from cultivation of a crop. Higher the yield, lesser the carbon foot prints. It implies that high yield varieties or farm practices that lead to higher yield help in lowering Carbon Foot print.

Farm practices were almost same amongst the farmers with small land holdings and the ones with large land holdings the difference is only in the quantity of any form of input specifically Agro chemicals and Diesel consumption.

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