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Water footprint for sustainable production

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Abstract
Water is essential for sustaining all forms of life, food production and economic development for general wellbeing. It is impossible to substitute for its uses, difficult to de-pollute, expensive to transport and it is truly a unique gift to mankind from nature. So it is necessity to use water efficiently and conserve for future generation. The water footprint is the volume of fresh water used to produce product summed over various steps of food production. It is geographically explicit indicator not only showing volume of water use and pollution but also the locations (Hoekstra, 2009). The total water footprint of a product breaks down into three components: the blue, green and grey water footprint. The blue water footprint is the volume of fresh water that evaporated from the global blue water resources (surface water and ground water) to produce the goods and services consumed by the individual or community. The green water footprint is the volume of water evaporated from global green water resources (rain water stored in the soil as soil moisture). The grey water footprint is the volume of polluted water that associates with the production of all goods and services for the individual or community.

Keywords: Water footprint, sustainable production, food production, economic development

Introduction
The concept of water footprint was introduced by Hoekstra in 2002. The volume of fresh water used to produce product, summed over a various steps of food production. The water footprint is a geographically explicit indicator, it not only e showing volume of water use and pollution but also the locations. The direct water is water used for domestic consumption. And indirect water is water used for industrial and agricultural production. The water footprint concept In line with the concept of virtual water, the concept of the water footprint has been introduced to create a consumption-based indicator of water use (Hoekstra & Hung, 2004; Hoekstra & Chapagain, 2007). This in contrast to the traditional production-sector-based indicators of water use, that are useful in water management but do not indicate the water that is actually needed by the inhabitants of a country in relation to their consumption pattern. The water footprint is defined as the volume of water needed for the production of the goods and services consumed by the inhabitants of a country. This concept is developed in analogy to the concept of the ecological footprint. The water footprint can be divided into an internal and an external water footprint. Finally, the water footprint can be divided into a blue, a green and a gray water footprint. The blue component covers the use of groundwater and surface water during the production of a commodity, the green component covers the use of rain water for crop growth, and the gray component covers the water required to dilute the water that is polluted during the production of the commodity. The distinction between green and blue water has been introduced). The gray component has been introduced by Chapagain *et al.* (2006) [5].

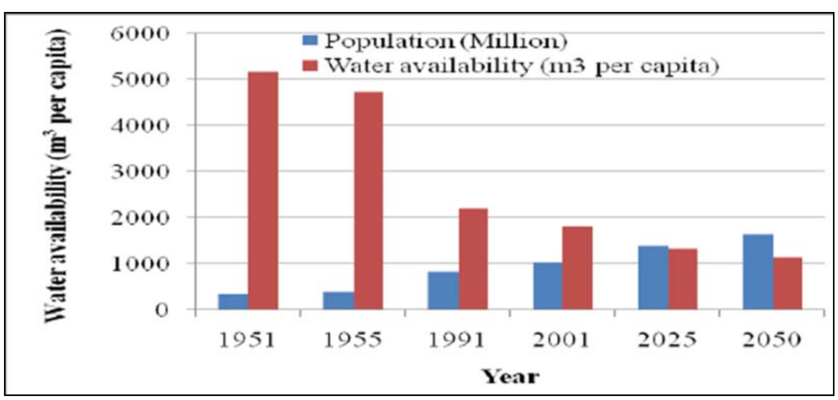

Fig 1: Per capita water availability in different years in India

Bandana *et al.* (2014) [3].

Bandana and his co-workers during 2014 they gave a report on per capita water availability in different years in India in This graph shows over a period of time the water availability goes on decreasing and population goes on increasing. Means the water demand is more than the supply. The water availability in 1991 and 2001 were 2309 and 1902 m³ per capita and this is projected to be reduce to 1401 and 1191 m³ per capita by 2025 and 2050.

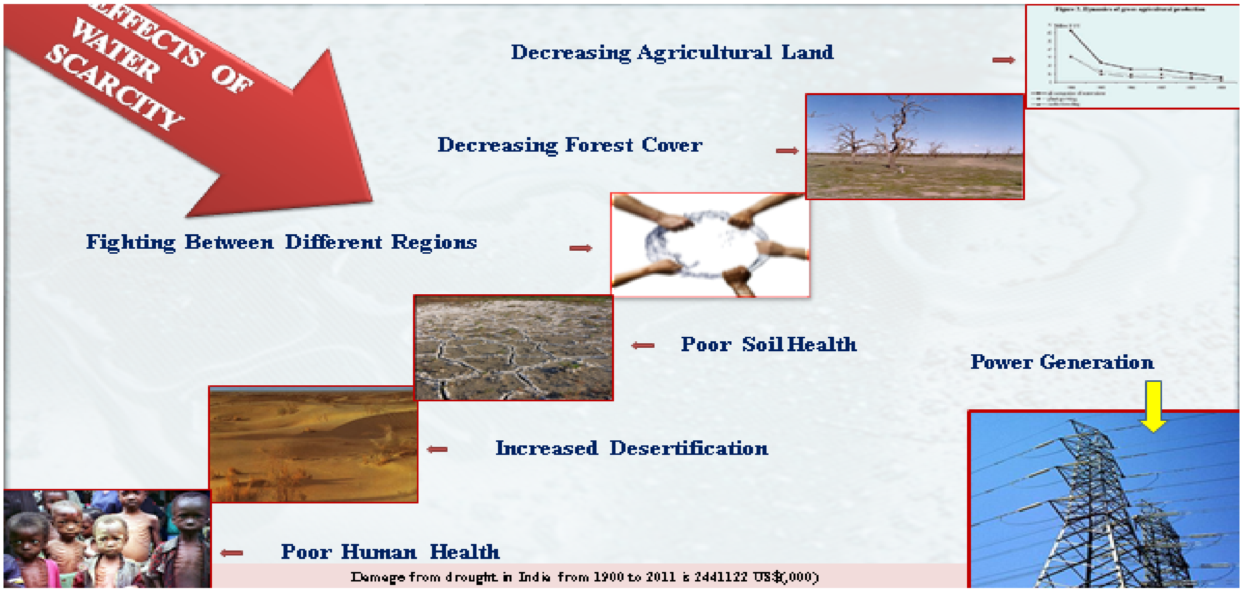

Fig 2: Effects of water scarcity

In this figure we can see due to scarcitey of water decreasing the agriculture land from one year to another year, decreasing the forest area, and also causes decreasing the forest area, due to scarcitey of water fighting between different regions current example for this is fighting between Karnataka and Tamilu Nadu peoples for cavarey watrer, soil health become poor and increased desertification due to water scarcitey power generation decreases and fiaaley reduction in yield and also causes poor human health.

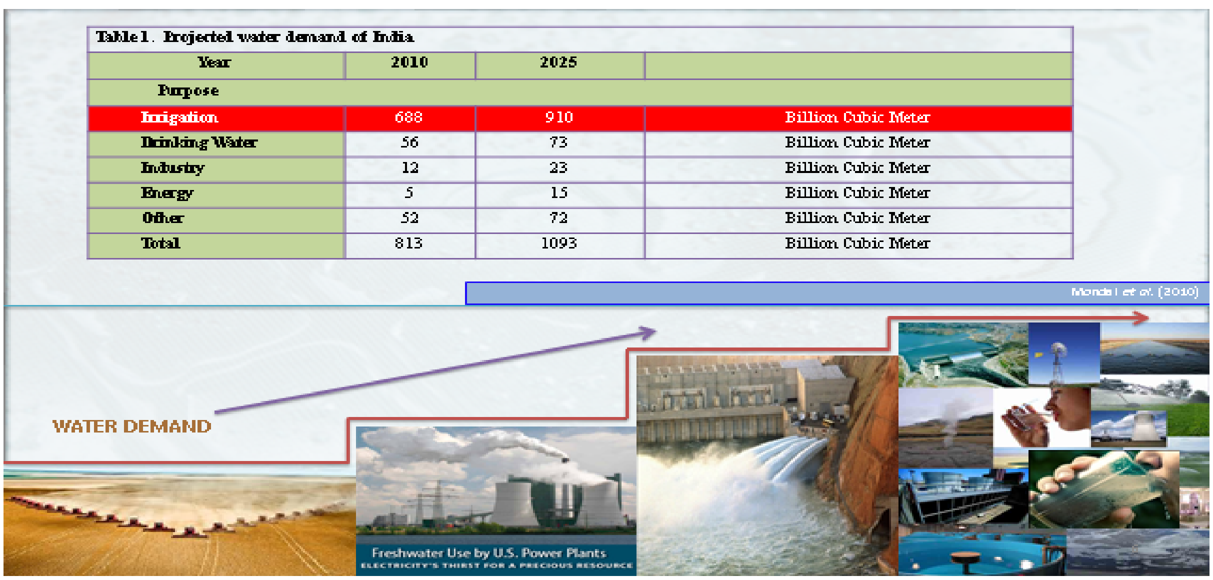

Table 1. Projected water demand of India

Year	2010	2025	
Purpose			
Irrigation	688	910	Billion Cubic Meter
Drinking Water	56	73	Billion Cubic Meter
Industry	12	23	Billion Cubic Meter
Energy	5	15	Billion Cubic Meter
Other	52	72	Billion Cubic Meter
Total	813	1093	Billion Cubic Meter

Fig 3: Project water demand of India

Mondal *et al.* (2010)

This table shows project water demand for water in India from one year another year goes on increasing for different purpouses.during 2010 project water demand for irrigatin is 688 billion cubic meter but for 2025 it was expected to 910 billion cubic meter.Project water demand is more for irrigation as compare to other sectors mainley because of agriculture sector is a major fresh water consumer and around 70 % of world is fresh water withdrawl for irrigation. Fresh water resource is unevenley distributed among the contry,thus information regarding water avilabality, crop water reqvirement in each region across the country is essential for planning water resources to satisfy the increase demand for food, feed and biofuel production in the futuer water foot print has been introdused.

Three colours of water

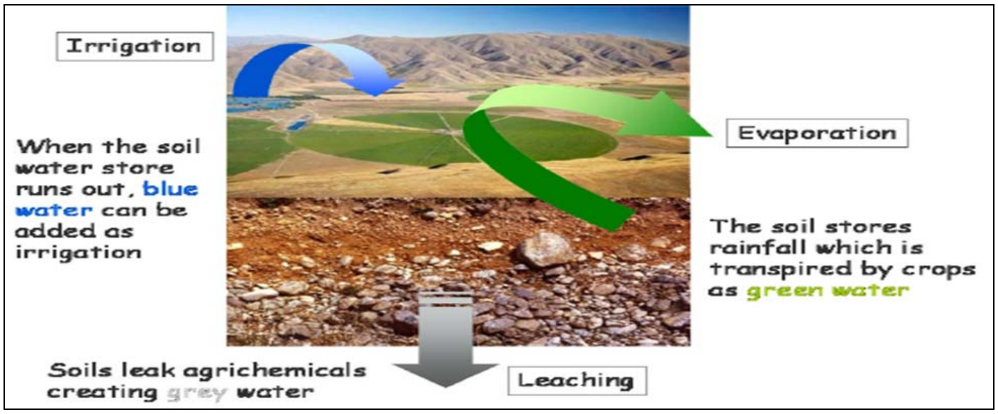

Fig 4: Three colours of water

Brent *et al.* (2010)
Figure two showing how the different components of water used. The green water losses from the soil as evaporation and from plants through transpiration. The blue water stored as ground water that is stored as green water used in production. Grey water is the polluted water for while producing crops.

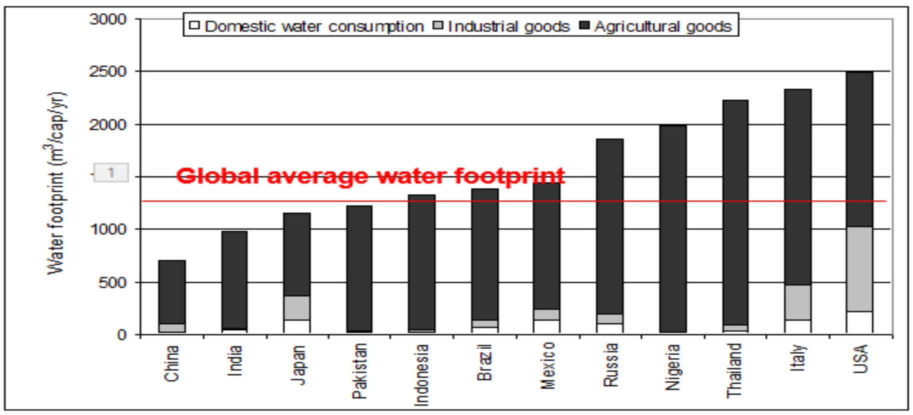

Fig 5: Water footprint per capita contribution of major consumers to the global water footprint

Hoekstra and Chapagain, 2008 [8]
It showing water used for different purposes like domestic water consumption industrial and agriculture goods. The global footprint is 7450 Gm³/year and average is about 1240 m³/cap/year
In India, Pakistan, Indonesia, Nigeria agriculture is the main occupation the more water is used for agriculture purpose only but in America. Japan and Italy along with agriculture they involved in production of industrial goods so more water foot print. Eight countries – India, China, the USA, the Russian Federation, Indonesia, Nigeria, Brazil and Pakistan – together contribute fifty percent to the total global water foot print. India (13%), China (12%) and the USA (9%) are the largest consumers of the global water resources Both the size of the national water footprint and its composition differs between countries On the one end we see China with a relatively low water footprint per capita, and on the other end the USA.

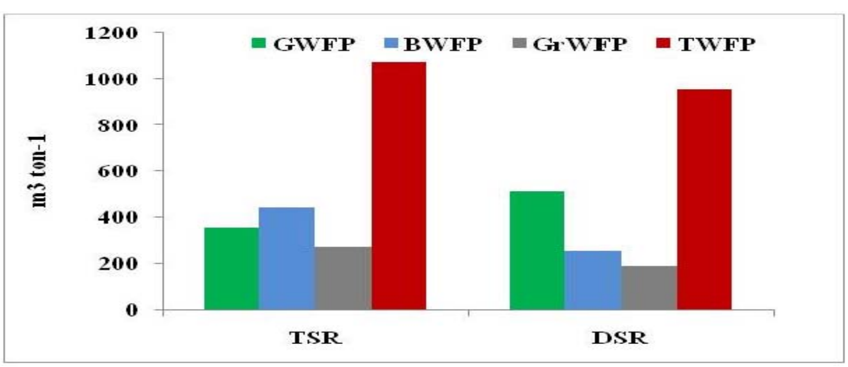

Fig 6: Water footprint of growing transplanted (TSR) and direct seeded rice (DSR).

Haryana Chakrabarti *et al.* (2010)
Chakrabarti and his co-workers during 2010 at Haryana they conducted research on water footprint of growing transplanted and direct seeded rice. Total water foot print of rice production was found to be 1071 M^3 ton^{-1} in case of transplanted rice application of irrigation water is less in Direct seeded rice by around 25%.This has resulted in less total water foot print in direct seeded rice.

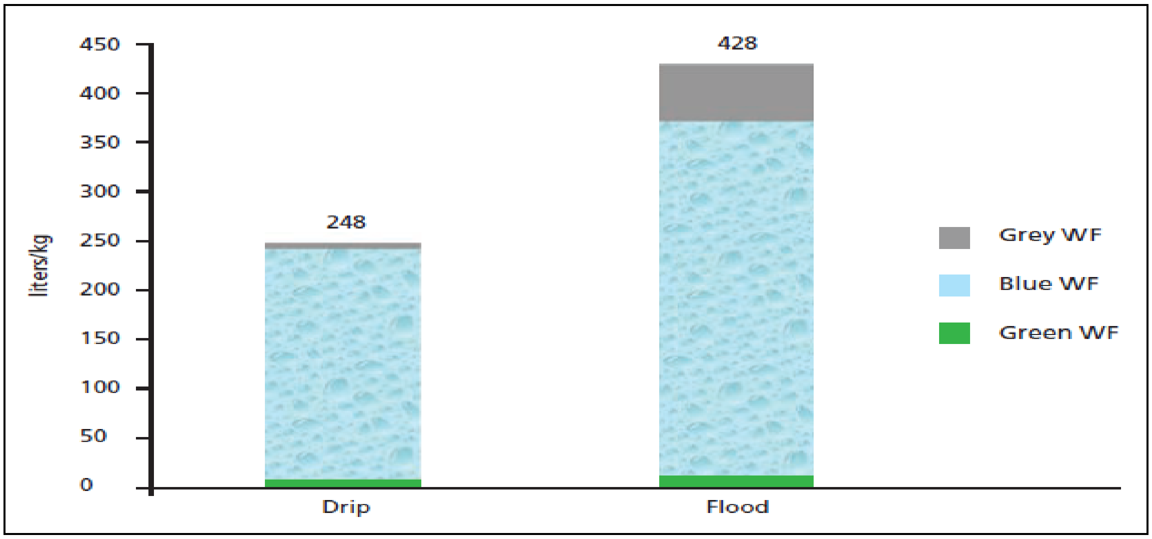

Fig 7: Three color components of the water footprints for raw onions grown under flood and drip irrigation.

Maharashtra Anon. (2009)

The results show that onions grown under drip irrigation have a 42% smaller water footprint than onions grown under flood irrigation. The largest component of the water footprints is the bluewater footprint, associated with irrigation water. The grey water footprint for onions grown under drip irrigation is almost 90% smaller than the grey water footprint for flood-irrigated onions,reflecting the lower leaching rate when water and nutrients are applied at the roots of the plants.

Grey water footprint

The fresh water polluted during production chain of product This is volume of fresh water that is required to assimilate the load of pollutants based on existing ambient water quality standards It is calculated as the volume of water that is required to dilute fertilizers and chemicals The volume of polluted water has been estimated using nitrogen as a representative element for estimations of grey water footprint.

GWF= f. LN÷ (CN,Max – CN, nat).Y

f =leaching fraction of Nitrogen

L N =Nitrogen application rate

C N,max = max.acceptable concentration of nitrogen

C N,nat = natural concentration of nitrogen

Y = actual crop yield

Grey water footprint is calculated as the volume of water that is required to dilute pollutants to such an extent that the quality of water remains above agreed water quality standards.

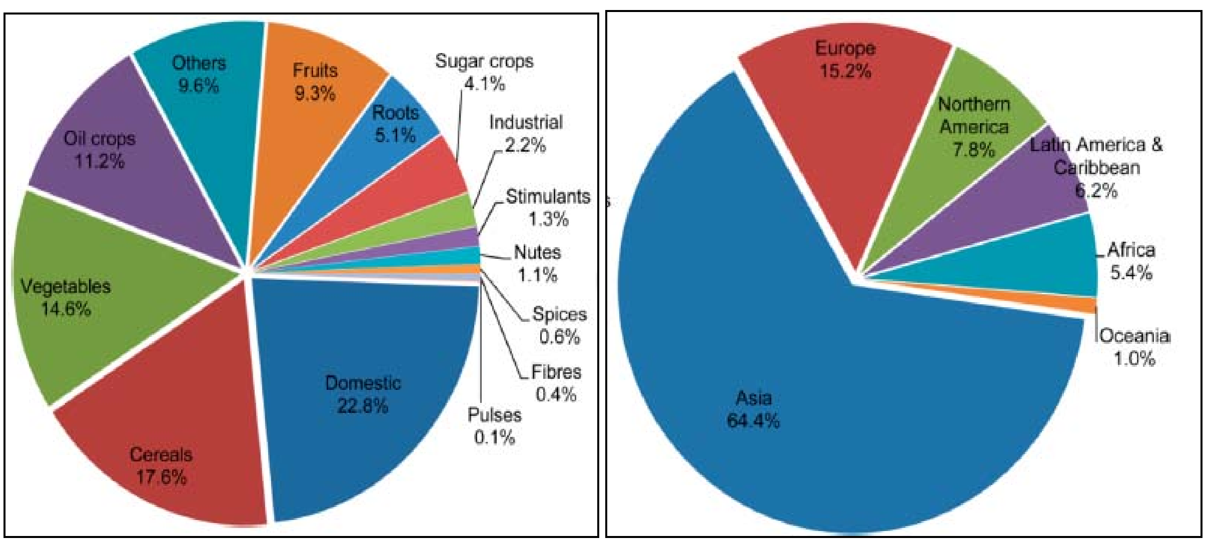

Fig 8: Relative contribution of different product categories and different regions to total grey water footprint related to nitrogen loads. Period: 2002−2010.

Netherland

Mekonnez. (2015)

The largest share (75%) come from diffuse source that is N leaching and runoff from croplands. Cereal production contributes 18% of global the global N related grey water footprint. N loads from the domestic sector account for 23% of the total GWF and industrial sector 2%. Looking at regional contributes Asia 2/3 to total GWF fallowed by Europe (15%).

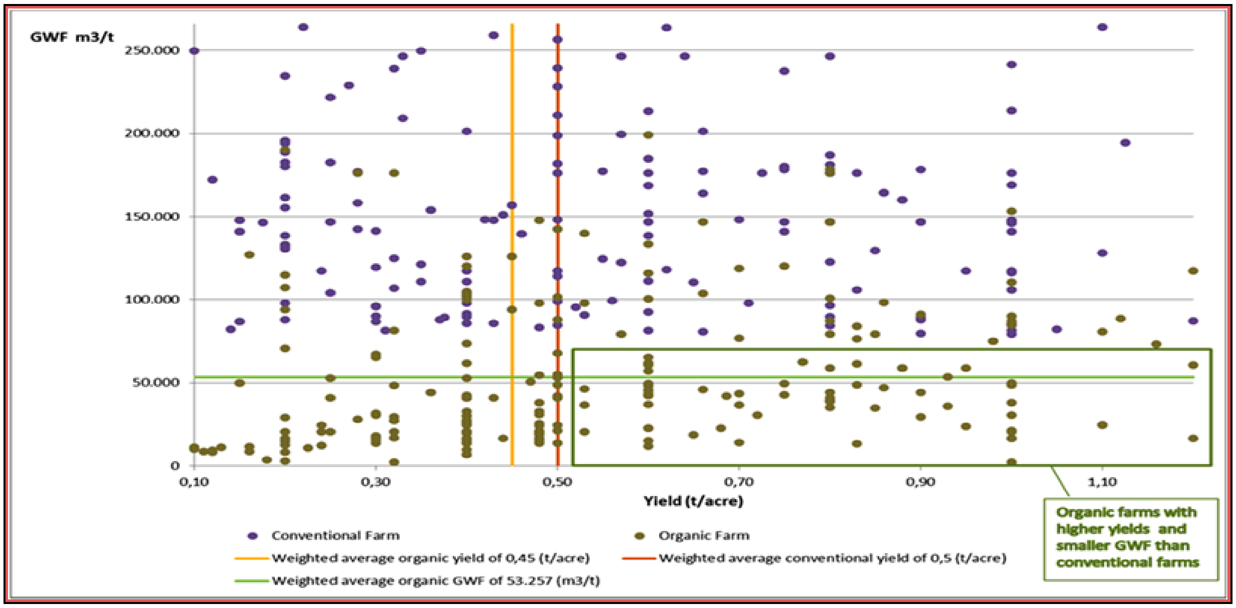

Fig 9: Comparing grey water footprint related to the corresponding yield between conventional and organic farmers.

Madhya Pradesh

Anon. (2011)

This figure shows the grey water foot print and corresponding yield for the conventional and organic analyzed which have a grey water foot print below the average conventional grey water foot print. Only three organic farms have large grey water foot print than the average conventional grey water foot of 266.042 m^2/t. All conventional farms lie above the organic average grey water foot print of 53.257 m^2/t, there are conventional farms with smaller grey water foot print and higher yields than organic farms. The conventional cotton farms in this study have large grey water foot print it is mainly due to pesticides. The grey water foot print per tonne of cotton due to pesticides in conventional farming is between 10 and 20 times larger than that due to nutrients in organic farming. Pesticide application resulting in such a large grey water foot print.

Table 1: Overall results of conventional and organic farming

Farming System	Surface area (acre)	Total production(t/year)	Average yield (t/acre)	Total GWF (m^3/year)	Average GWF (m^3/t)
Conventional	1.272	635	0,50	168.95	266.04
Organic	1.271	577	0,45	30.70	53.25

Madhya Pradesh

Anon. (2011)

This table explains overall results of conventional and organic farming. The samples for both farming systems consisted of 240 farms, with a total surface of 1272 acres of conventional farming and 1271 acres of organic farming. The overall results of the two farming systems. The total production of 635 t in one year for the conventional farms is slightly higher than the 577 t of organic production; it does not justify the 5.5 time larger total grey water foot print. The grey water foot print of conventional farming is around 168.95 m^2year; the one for organic farming is 30.703 m^2/year. The average grey water foot print for the production of one tonne of cotton using conventional farming is around 266.04 m^2/t. The average yields only differ by 10 %, with conventional farming being more productive with 0.5 tonnes per acre versus 0.45 tonnes per acre for organic farms.

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