Tilda Indian basmati rice sustainability programme (TBSP): carbon dioxide equivalent emissions methodology, baseline and variables used

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1. Introduction

This document details the methodology, baseline, variables, assumptions, and key sources used to calculate the carbon dioxide equivalent (CO2e) emissions at the farm level in the Tilda Basmati Sustainability Programme (TBSP).

2. Terminology

In the analysis and quantification of greenhouse gas emissions associated with the production and use of inputs in agricultural production systems, GHG emissions may arise from the emission of several gases, of which the most common are carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). As a specific unit of each gas (eg, 1 kg) is not equivalent in terms of its greenhouse gas emission, comparisons are usually referred to in carbon dioxide equivalents (CO2e), with conversions into CO2e of a particular gas made using what is known as the global warming potential (GWP) of each gas. For example, the GWP of non-fossil fuel methane (CH4) is 27.3 meaning that 1kg of methane emitted is the equivalent of 27.3 kg of carbon dioxide. The GWP of nitrous oxide (N2O) is 273 meaning that 1kg of nitrous oxide emitted is the equivalent of 273 kg of carbon dioxide[1].

3. What is the definition of sustainable farming used in this programme?

To be sustainable, agriculture must meet the needs of present and future generations for its products and services while ensuring profitability, environmental health and social and economic equity – This follows the Food and Agriculture Organisation of the United Nations' definition.

A more sustainable agricultural supply chain has three main focuses:

- Economic: helping farmers earn a stable income and achieve security
- Environmental: finding ways to reduce harmful effects on the environment like reducing greenhouse gas emissions and use less water and energy
- Ecological: supporting nature by improving biodiversity

4. Sustainability aim

The programme aims to be more sustainable by partnering with the farmers who grow the rice because protecting natural resources, bio-diversity and reducing emissions requires balance and support to farmer livelihoods.

5. The programme has three main components:

- The provision of a farm level advice service on husbandry practices and input use (eg, fertiliser and pesticide use)
- The operation of integrated forms of pest management (IPM) via the provision of equipment such pheromone traps to influence/guide the use of crop protection products and spider bundles as a form of biological control of some pests. The IPM helps reduce the environmental footprint of pest control practices and supports biodiversity.

[1] Source: http;//ghgprotocol.org/sites/default/files/2024-08/

Farmers are given advice and free pheromone traps to attract insect pests which help determine pest levels in fields and enable better targeted (and reduced) use of crop protection products. The straw bundles create a habitat for spiders which act as a natural form of 'biological' pest control

- The provision of equipment and advice to implement the alternate wet and dry (AWD) irrigation technique, developed by the International Rice Research Institute (IRRI). This is a more sustainable way of growing rice that allows fields to largely dry out between floods (see below for additional information).

6. Extent of programme

- In 2025, the wider programme of extension service assistance relating to input use and IPM operation was with 5,800 basmati farmers in the Indian states of Haryana and Uttar Pradesh. The AWD programme was first piloted in 2021 on 50 farms and has significantly expanded since then so that in 2025, it was with 3,840 farmers on 15,314 hectares of rice
- Each year, farmers can choose to join the programme of assistance, where they agree to follow the farming standards required to meet the company's quality specifications. In return, they are provided with advice, inputs and equipment
- Farmers can choose to sell their rice to Tilda or not - there is no requirement to do so. If they do sell to Tilda, they receive a price premium that reflects the production risks of growing basmati relative to other rice types – lower average yields and a longer growing season that increases the risk of damage from pests and diseases
- The approach aims to provide a secure outlet for their rice and a degree of income security

7. More on reducing methane emission

- Traditional rice farming uses between 3,000 and 5,000 litres of water per kilogram of rice as the crop is usually grown in permanently flooded fields. This produces large amounts of methane, a powerful greenhouse gas that contributes to climate change and is a by-product of the anaerobic process that takes place when rice plants grow in flooded fields
- The alternate wet and dry (AWD) irrigation technique, developed by the International Rice Research Institute (IRRI), is a more sustainable way of growing rice that allows fields to largely dry out between floods. This method uses less water and lowers the amount of time rice plants are flooded, reducing the release of methane
- There is a considerable body of scientific research that has assessed the impacts of AWD, and drawn on by the International Panel on Climate Change in its latest estimates (IPCC 2019). This shows that adopting AWD can reduce methane emissions by 45% when compared to continuously flooded paddy fields. This is the default emission reduction value applied to all production on farms in the AWD operating part of the TBSP, as used in the farm level carbon emission calculator tool (the Cool Farm Tool: see below)
- In a traditional continuously flooded rice production system, farmers would usually carry out 20-25 flooding cycles per growing season. The AWD using farms typically carried out at least five fewer flooding cycles. Evidence from the (three years) 2023-2025 crops, shows that this

resulted in water use and the electricity required to irrigate the crop falling by about a quarter

8. Verification of the programme outcomes

- The approach is science-based and evidence-led. It is guided by the findings of scientific literature and the activities of international bodies like IRRI and the IPCC. It also collects real-world data from farms to identify the specific impacts of the programme
- Data is collected on key input use and farming practices from representative samples of farms in the Indian basmati supply chain. This data comes from two sub-sets of farmers (see below): those that use AWD irrigation practices, receive advice and apply integrated crop management practices; and a separate sample of farms that use traditional practices of continuous flooding and crop protection more reliant on the prophylactic application of pesticides
- The data collected from these samples is input into a widely-used farm-level greenhouse gas (GHG) emission calculator tool (the Cool Farm Tool (CFT), set up in the UK, which is one of the few tools with a specific module for rice production) to estimate the carbon dioxide equivalent emission savings that have occurred with our AWD and related farmer assistance programmes. The CFT draws on the peer-reviewed scientific literature and the work of the IPCC in its assumptions for calculating GHG emissions
- Assessment of the impact of the integrated pest management approach involves the collection of data on pesticide use to the active ingredient level and utilises an indicator known as Environmental Impact Quotient indicator (EIQ)[21] developed at Cornell University (USA)
- Verification that farmers are operating AWD effectively is provided through a combination of IOT[3] soil sensors of water levels during the growing season in a sample of farms and from satellite monitoring undertaken by the external provider Carbon Farm

9. Data collection from farms

Farm level data is collected from samples of farms in the Tilda basmati supply chain that are reasonably representative of the Tilda supply base.

Samples are set for two categories of farmers: those that use AWD irrigation practices, receive advice and apply integrated crop management practices and a separate sample of farms (non AWD) that use traditional practices of continuous flooding, crop protection that is more reliant on the

[2] The EIQ distils the various environmental and health impacts of individual pesticides in different production systems into a single 'field value per hectare' and draws on key toxicity and environmental exposure data related to individual products. It is an indicator, primarily of toxicity and does not take into account all environmental issues and impacts EIQ | CALS (cornell.edu)

[3] IoT stands for Internet of Things and refers to soil sensors that monitor and transmit data about soil conditions (in this case water levels in/on the soil). These help farmers with irrigation (flood) management of the rice crop

prophylactic application of pesticides and farmers do not receive advice from the Tilda extension team.

The samples are stratified by the approximate breakdown of regions/districts and size of farms of the previous year's supply base. The samples set for 2025, based on the 2024 supply base are shown in the tables below.

AWD sample 2025

Haryana		
District	**Target**	**Delivered**
Sirsa	6	6
Rajpura	2	2
Fatehabad	4	4
Maler Kotia	1	1
Jind (Safidon)	7	7
Koshi Kalan	1	1
Panipat (Madlauda)	3	3
Yamuna Nagar	17	17
Kurukshetra	19	19
Total	**60**	**60**
Farm size		
Under 5 hectares	40	39
5-10 ha	11	11
10-20 ha	7	8
Over 20 ha	2	2
Total	**60**	**60**
Uttar Pradesh		
District	**Target**	**Delivered**
Aligarh	50	54
Bulandshahr	25	21
Total	**75**	**75**
Farm size		
Under 1 hectare	15	14
1-2 ha	32	33
2-5 ha	22	21
Over 5 ha	6	7
Total	**75**	**75**

Non-AWD sample 2025

Haryana		
District	**Target**	**Delivered**
Sirsa	6	6
Rajpura	2	2
Fatehabad	4	3
Maler Kotia	1	2
Jind (Safidon)	7	7
Koshi Kalan	1	1
Panipat (Madlauda)	3	3
Yamuna Nagar	17	18
Kurukshetra	19	18
Total	**60**	**60**
Farm size		

Under 5 hectares	40	41
5-10 ha	11	11
10-20 ha	7	7
Over 20 ha	2	1
Total	**60**	**60**
Uttar Pradesh		
District	**Target**	**Delivered**
Mathura	30	33
Gautam Budhha Nager	20	17
Total	**50**	**50**
Farm size		
Under 1 hectare	8	7
1-2 ha	25	25
2-5 ha	12	13
Over 5 ha	5	5
Total	**50**	**50**

Note:

1. As all farms not using AWD in Utar Pradesh were in Mathura and Gautam Budhha Nager districts, the sample of non-AWD farms was taken entirely from these two districts

10. Variables included in CO2e calculations

Category	Variable	Additional information
Crop	Year	
	Area (hectares)	Varies by farm
	Yield and production (tonnes)	Varies by farm
Residue management	Amount (tonnes/ha)	Varies by farm
	Management	All farms both inside and outside TBSP removed from field
	Co-products	All farms both inside and outside TBSP: none
Soil	Texture	Silt medium: all farms in region
	Moisture level	Comes from climate zone for region in CFT: same for all farms
	Soil organic matter %	Range 1.72 to 5.16 all farms
	Soil organic carbon %	2% all farms
Flooding (variables for calculating methane emissions)	Time under cultivation (days)	Basmati is typically in range 110-120: 115 was the average across all farms in 2025 used
	Water management pre growing season	Not flooded pre-sowing for greater than 180 days all farms
	Water management during cultivation	Continuous flooding for farms outside TBSP. Intermittent flooding (multiple aeration) for farms in the TBSP
Fertiliser use: 2 separate calculations that include manufacture and distribution to farms and in field use (which is used for calculating nitrous oxide emissions)	Type	Main ones being urea, di-ammonium phosphate (DAP) and mono-ammonium phosphate (MAP): all farms
	Manufacture region	SE Asia: all farms

	Application rate (kg/ha of product)	Varies by farm
	Method of application	Broadcast all farms
	Date of application	Varies by farm
	Emissions inhibitor use	All farms using
Pesticide use: includes manufacture and distribution to farms and in field use	Category of pesticide: fungicide, herbicide, insecticide	
	Rate applied (kg/product per ha)	Varies by farm
	Active ingredient %	Depends on products used: varies by farm
Green manure management	Not applicable: all farms	
Energy use	Diesel (litres): for farm husbandry, soil preparation and some harvesting	100% mineral origin assumed all farms: usage varies by farm
	Electricity (KWh): for pumping irrigation water	Mostly from the national grid all farms: amounts used vary by farm
In crop carbon changes	Applicable if there have been land use changes in the last 20 years affecting soil carbon retention levels	Not applicable as no changes to underlying soil management: all farms
Transport (of crop from farm to market)	Mode	Small LGV diesel lorry: all farms
	Weight (tonnes) of crop sold	Varies by farm
	Distance to market (km)	Varies by farm

Notes:

1. Categories pre-determined at the regional level (eg, soil texture, moisture levels) set by farm carbon emission calculator tool – the Cool Farm Tool
2. All variables for which values vary by farm drawn from annually operated farm sample survey

11. Baselines

The baseline used to calculate the emissions presented in the 2025 Tilda Sustainability report is the average of the three years 2023 to 2025 - the comparisons between the farms in the TBSP and those outside the TBSP are based on the average of the three years data for each sub-set of farms in the two samples (inside the TBSP and those outside the TBSP).