

# Sustainable Farming in Ghana

## A comparison of GHG emissions and GDP

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### Introduction

Approximately 52% of Ghana's labour force<sup>1</sup>, which is estimated to be made up of around 15 million men and women, is engaged in agriculture. Unsurprisingly, many of this industry's processes produce a lot of greenhouse gases, including carbon dioxide, nitrous oxide and methane; the latter being primarily due to livestock farming and landfill. Deforestation could potentially exacerbate the problem as it means there are fewer trees to absorb the carbon dioxide emitted.<sup>2</sup> It was also estimated in 2005 that the annual

municipal solid waste generated by agricultural activity in Ghana was around 3,538,275 tons.<sup>3</sup>

The purpose of this analysis is to study the effect of the agriculture industry in Ghana on the environment, though it will focus on greenhouse gas (GHG) emissions rather than waste produced or deforestation. It will also look at the country's Gross Domestic Product (GDP), as well as any correlation present between the two. Some of the factors that influence these two metrics will also be considered, in order to predict what they might look like in the coming decade, and to find out how sustainable Ghana's farming industry really is.

## **The effect of agriculture in Ghana on climate change**

According to the USDA Foreign Agricultural Services, the Agriculture, Forestry and Other Land Use industry is not just a major contributor, but the biggest contributor to GHG emissions in Ghana. In 2016, for example, it contributed 54.4% of the country's total emissions.<sup>4</sup>

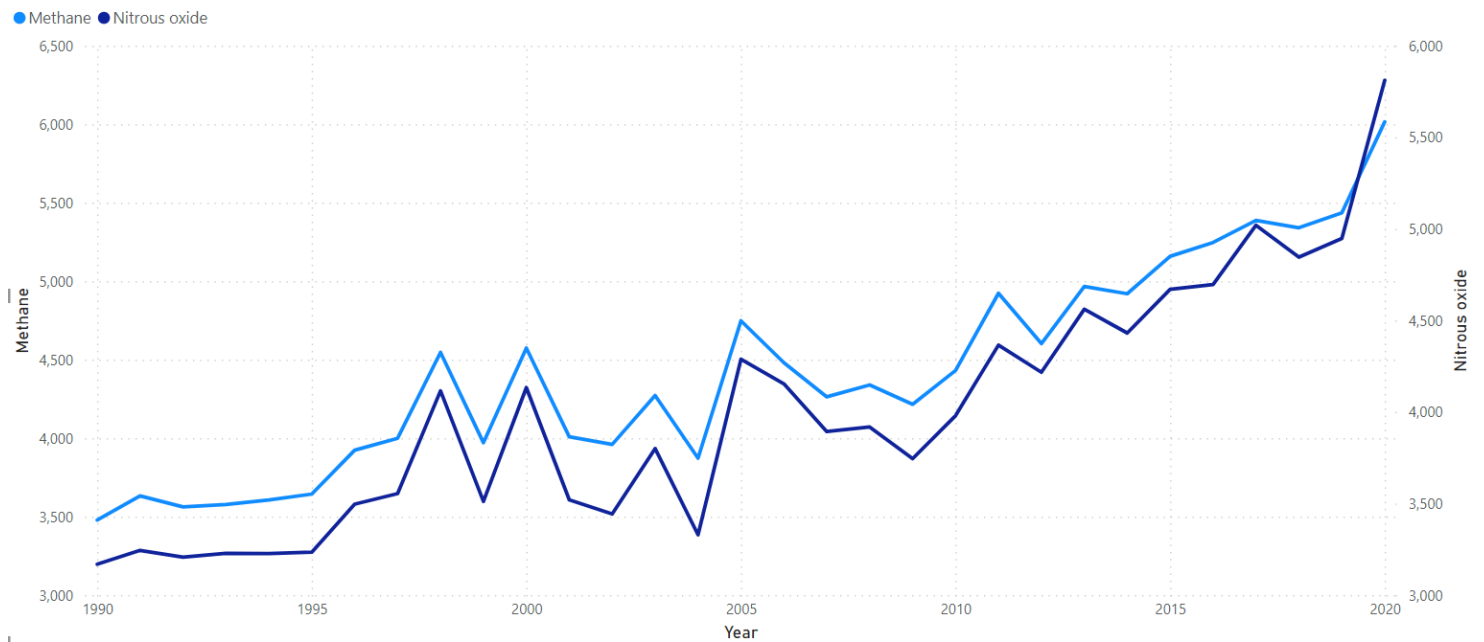
A rise in the number of livestock and frequent burning of biomass through land clearing from 1990-2011 furnished an increase of emissions. Despite the growth in livestock farming, the agriculture sector still relies on quite basic technology.<sup>5</sup> This means we may see less emissions partly due to the lack of potentially highly-polluting machinery.

As methane and nitrous oxide are two of the main gases responsible for damaging our ozone layer I looked at the data for agricultural nitrous oxide and methane emissions in Ghana from 1990-2020.<sup>6</sup>

After plotting the data we can see quite clearly, for example, that methane emissions from agricultural activity mostly surpassed nitrous oxide emissions during this time period, except from in 2020. Emissions of both gases seem to follow the same or a similar trend, which may indicate that they are mostly produced from activities which result in emissions of both gases rather than just one or the other.

Over this time period there seems to be a general upward trend in the emissions of both greenhouse gases, as we might expect with recent technological advances.

**Methane and Nitrous Oxide Emissions by Year**  
(Thousand metric tons of CO<sub>2</sub> equivalent)



## What greenhouse gas emissions might look like by 2030

Estimates for the percentage of total land mass consisting of agricultural land, which is defined as arable land (land which can be used to grow crops temporarily or otherwise), permanent crops or permanent pasture for our purposes, can be found on [statista.com](https://www.statista.com) for the years 2008 to 2020. The data, which exhibits no apparent overall trend, suggests that this statistic will continue to remain stable, and therefore is not likely to have a noticeable impact on future greenhouse gas emissions.<sup>7</sup>

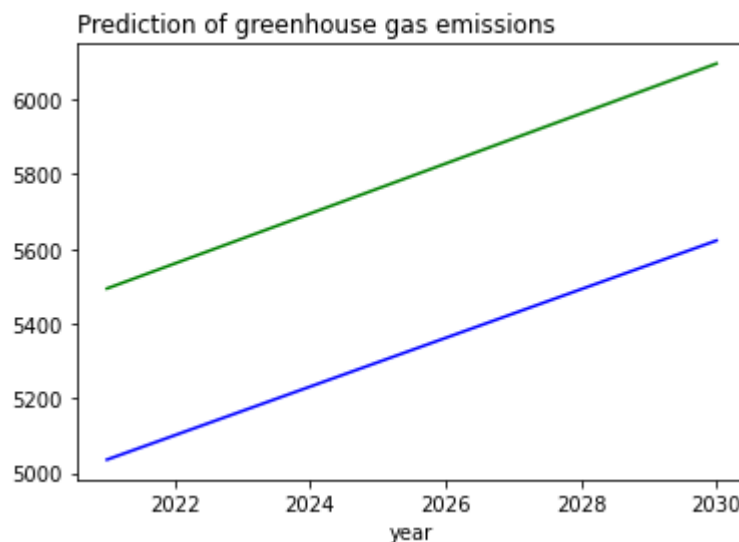
The same website presents data for forest share of land area in Ghana for the years 2001-2020.<sup>8</sup> As there is no significant decrease in this statistic during this time period, it is unlikely that deforestation will contribute to an increase in GHG emissions over the next few years.

A summary of ownership and use of agricultural equipment can be found in section 13.4 of the 2017/18 Ghana Census of Agriculture.<sup>9</sup> What is found confirms a theory earlier in the report that there is not a large amount of polluting machinery being used in this country's

agricultural industry - less than 4.4% of a total of 2,158,697 farm owners used equipment other than knapsacks when this survey was conducted.

Similar summaries of livestock production (13.5.3) and total agricultural production (13.7.4) are available from the census.

Python generated predictions for 2021 to 2030 are shown in the graph below, with methane emissions in green and nitrous oxide emissions in blue. This was done using linear regression since the existing data was seen to follow a fairly linear relationship.

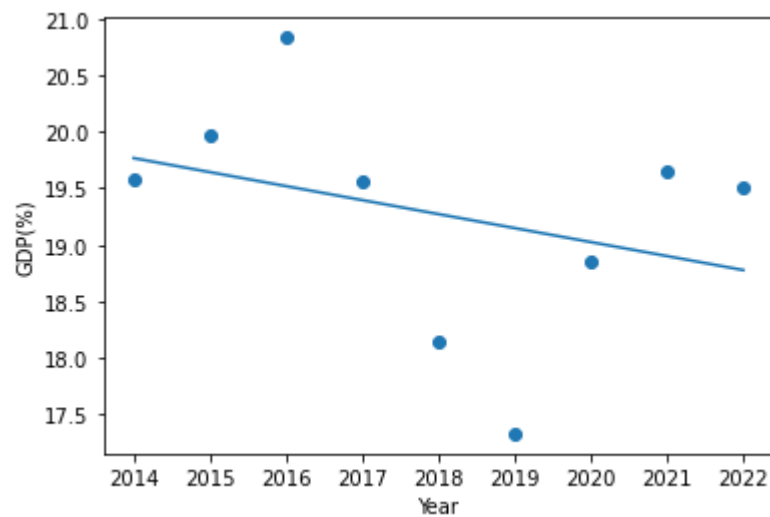


## Contribution to value-added Gross Domestic Product

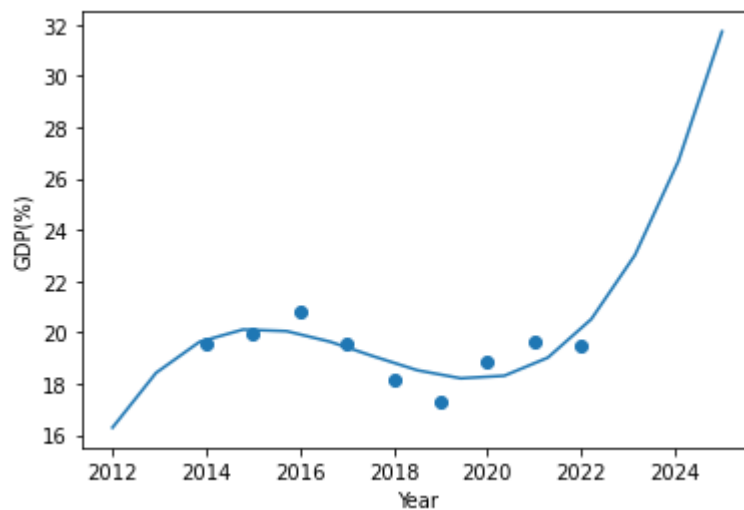
According to the latest figures from the UN's Food and Agriculture Organisation, the sector made up 54% of Ghana's GDP, 40% of its export earnings and provided 90% of the population's food needs in 2001.<sup>1</sup> As of 2022, the agricultural sector had a share of 19.51% of value added to Ghana's GDP.<sup>10</sup>

### A prediction of agriculture's GDP(%) contribution for the next decade

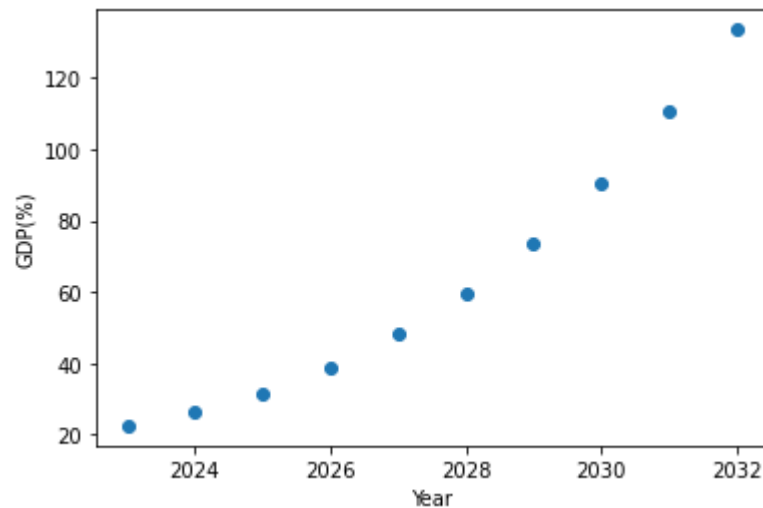
We first use a linear regression model to check for linearity in the data<sup>10</sup> using the resulting line of best fit:



There does not seem to be a linear relationship so we check to see if a cubic regression model will be more suitable:



The curve above shows a better fit, which is supported by an R-squared value of 0.545. Cubic regression results in the following predictions, shown here in a scatterplot. The values on the y-axis are given in percentages, which suggests this method may only be suitable for shorter-term predictions, as the last two predictions are certainly out of range.

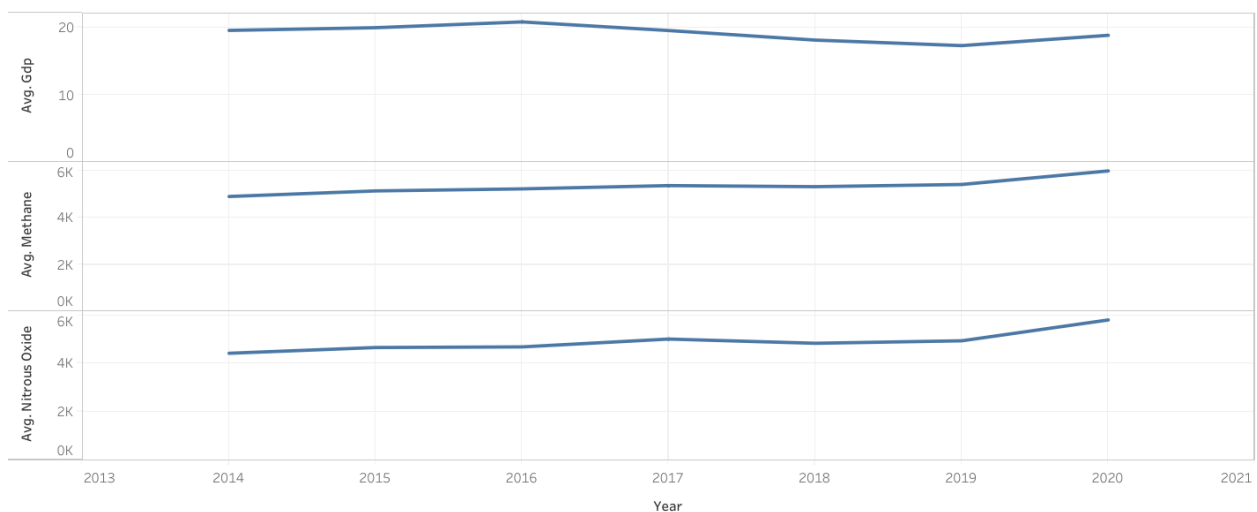


## Carbon Intensity of GDP

Carbon intensity is defined in this context as the ratio of greenhouse gas emissions to gross domestic product. A lower carbon intensity is reflective of periods when Ghana was more 'carbon-efficient' <sup>11</sup>, that is, when less carbon dioxide emissions were required to boost the country's economy.

The two are inextricably linked so one might expect them to have a fairly linear relationship. I have plotted these variables below to get a better idea of whether this is really the case.

Sheet 1



## Conclusion

Although the GHG emissions modelled here are predicted to increase over the next few years, the carbon intensity of GDP is not constant, meaning it is possible to improve the agricultural sector's contribution to the economy, without having to compromise on sustainability and the aim to reduce emissions.

## References

Used SQL to join methane\_emissions and nitrous\_oxide\_emissions tables before analysis. Visualisations created in Tableau, Python and Power BI. Python code used for reading csv files and for predictive modelling can be found in my GitHub repository: "farming\_ghana".

Any websites referred to or datasets used to create visualisations for this report are listed below in order of their first appearance.

<i>Name</i>	<i>Type</i>	<i>Link</i>
1. Ghana at a glance	Article	<a href="https://www.fao.org">fao.org</a>
2. Could Sunak's green review threaten UK net zero? - BBC News	Article	<a href="https://www.bbc.co.uk">bbc.co.uk</a>
3. The World Factbook, Ghana - CIA	Encyclopedia	<a href="https://www.cia.gov">cia.gov</a>
4. Ghana Climate Change Report - USDA Foreign Agricultural Services	Report	<a href="https://fas.usda">fas.usda</a>
5. GHG Emissions Factsheet Ghana	Facts and Figures	<a href="https://www.climatelinks.org">climatelinks.org</a>
6. Methane and nitrous oxide emissions	Dataset(s)	<a href="https://data.worldbank.org">data.worldbank.org</a>
7. Total agricultural land in Ghana	Dataset	<a href="https://www.statista.com">statista.com</a>
8. Forest area as share of land area in	Dataset	<a href="https://www.statista.com">statista.com</a>

<i>Name</i>	<i>Type</i>	<i>Link</i>
Ghana		
9. 2017/18 Ghana Census of Agriculture, National Report	Report	<a href="https://statsghana.gov.gh">statsghana.gov.gh</a>
10. Share of value added by the agricultural sector to the gross domestic product (GDP) in Ghana from 2014 to 2023	Dataset(s)	<a href="https://www.statista.com">statista.com</a>
11. List of countries by carbon intensity of GDP	Article	<a href="https://www.wikipedia.org">wikipedia.org</a>