



Food and Agriculture Organization
of the United Nations

FAO Statistics Working Paper Series

Issue 21/29

**METHODS FOR ESTIMATING GREENHOUSE GAS
EMISSIONS FROM FOOD SYSTEMS
PART III: ENERGY USE IN FERTILIZER MANUFACTURING,
FOOD PROCESSING, PACKAGING, RETAIL AND
HOUSEHOLD CONSUMPTION**

METHODS FOR ESTIMATING GREENHOUSE GAS EMISSIONS FROM FOOD SYSTEMS

PART III: ENERGY USE IN FERTILIZER MANUFACTURING, FOOD PROCESSING, PACKAGING, RETAIL AND HOUSEHOLD CONSUMPTION

Francesco N. Tubiello, Alessandro Flammini, Kevin Karl, Griffiths Obli-Laryea, Sally Yue Qiu,
Hörn Halldóruddóttir Heiðarsdóttir, Xueyao Pan and Giulia Conchedda

Required citation: Tubiello, F.N., Flammini, A., Karl, K., Obli-Laryea, G., Qiu, S.Y., Heiðarsdóttir, H., Pan, X., Conchedda, G. 2021. Methods for estimating greenhouse gas emissions from food systems. Part III: energy use in fertilizer manufacturing, food processing, packaging, retail and household consumption. FAO Statistics Working Paper Series, No. 29. Rome. <https://doi.org/10.4060/cb7473en>

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO.

ISBN 978-92-5-135244-1

© FAO, 2021



Some rights reserved. This work is made available under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 IGO licence (CC BY-NC-SA 3.0 IGO; <https://creativecommons.org/licenses/by-nc-sa/3.0/igo/legalcode>).

Under the terms of this licence, this work may be copied, redistributed and adapted for non-commercial purposes, provided that the work is appropriately cited. In any use of this work, there should be no suggestion that FAO endorses any specific organization, products or services. The use of the FAO logo is not permitted. If the work is adapted, then it must be licensed under the same or equivalent Creative Commons licence. If a translation of this work is created, it must include the following disclaimer along with the required citation: "This translation was not created by the Food and Agriculture Organization of the United Nations (FAO). FAO is not responsible for the content or accuracy of this translation. The original [Language] edition shall be the authoritative edition."

Disputes arising under the licence that cannot be settled amicably will be resolved by mediation and arbitration as described in Article 8 of the licence except as otherwise provided herein. The applicable mediation rules will be the mediation rules of the World Intellectual Property Organization <http://www.wipo.int/amc/en/mediation/rules> and any arbitration will be conducted in accordance with the Arbitration Rules of the United Nations Commission on International Trade Law (UNCITRAL).

Third-party materials. Users wishing to reuse material from this work that is attributed to a third party, such as tables, figures or images, are responsible for determining whether permission is needed for that reuse and for obtaining permission from the copyright holder. The risk of claims resulting from infringement of any third-party-owned component in the work rests solely with the user.

Sales, rights and licensing. FAO information products are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org. Requests for commercial use should be submitted via: www.fao.org/contact-us/licence-request. Queries regarding rights and licensing should be submitted to: copyright@fao.org

Abstract

This paper is part of a series detailing new methodologies for estimating key components of agri-food systems emissions, with a view to disseminate the information in FAOSTAT. It describes methods for estimating greenhouse gas (GHG) emissions from fossil fuel-based energy use in agri-food system processes outside agricultural land, i.e. those associated with pre- and post-production activities – in an effort to inform countries of the environmental impacts of agri-food systems and the possible options to reduce them. Based on the proposed methodology, we build a new database of the annual carbon footprint of energy use in pre- and post-production agri-food system processes, on a country basis and with global coverage, for the period 1990–2019.

Our efforts help to better characterize agri-food systems and the role they can play in achieving the Sustainable Development Goals (SDGs). In particular, they align well with SDG 12 to ensure “sustainable consumption and production patterns”, specifically Target 12.2, “achieve the sustainable management and efficient use of natural resources” and Indicator 12.2.1, which monitors the “material footprint, material footprint per capita, and material footprint per GDP” of different products.

This paper covers five categories of energy use in agri-food systems: (1) fertilizer manufacturing; (2) food processing; (3) packaging; (4) retail; and (5) household consumption. Methods for estimating GHG emissions from other agri-food system processes and complementing this work are discussed elsewhere (Tubiello *et al.*, 2021), specifically in relation to estimating emissions from food transport (Karl and Tubiello, 2021a), waste disposal (Karl and Tubiello, 2021b) and on-farm energy use (Flammini *et al.*, 2021).

Contents

Abstract.....	iii
Acknowledgements.....	vi
1 Introduction	1
2 General methods	3
2.1 Mapping agri-food systems components	3
2.2 Emissions estimates	5
3 Methods by agri-food systems component.....	7
3.1 Fertilizers manufacturing	7
3.2 Food processing	9
3.3 Food packaging	10
3.4 Food retail	12
3.5 Household consumption.....	13
4 Imputation of missing countries and results	17
4.1 Imputation of missing countries	17
4.2 Validation of results: pre and post production totals.....	18
4.3 Validation of results: agri-food systems components	19
4.4 Country level comparisons.....	23
5 Limitations and next steps	25
5.1 Boundaries of this analysis.....	25
5.2 Uncertainty	25
5.3 Areas for advancement.....	25
6 References	27

Acknowledgements

This paper has been drafted by Francesco Tubiello, Alessandro Flammini, Kevin Karl, Griffiths Obli-Laryea, Sally Yue Qiu, Hörn Halldórudóttir Heiðarsdóttir, Xueyao Pan and Giulia Conchedda.

Many principles of this methodology were built on previous FAO work on the use of energy in agri-food systems, led by Olivier Dubois. We are thankful to Cynthia Rosenzweig, Philippe Benoit, David Sandalow, Erik Mencos Contreras, Matthew Hayek and the Food Climate Partnership for their useful inputs and comments, which helped to improve the quality of this work. We are also thankful to Leonardo Sousa at the United Nations Statistics Division (UNSD) for support with data provision.

预览已结束，完整报告链接和二维码如下：

https://www.yunbaogao.cn/report/index/report?reportId=5_22331

