DCN
version 1.0

September 2017

Version

NASA Making Earth System Data Records for Use in Research Environments (MEaSUREs) Global Food Security-support Analysis Data (GFSAD) @ 30-m for North America: Cropland Extent Product (GFSAD30NACE)

User Guide

USGS EROS
Sioux Falls, South Dakota

Document History

Document Version	Publication Date	Description
1.0	September, 2017	Original

Contents

1 Dataset Overview

The goal of the Global Food Security-support Analysis Data @ 30-m (GFSAD30) project is to provide the highest resolution, objective cropland datasets to assist and address global food and water security issues in the twenty-first century. The project proposed developing cropland products using time-series Landsat and Sentinel satellite sensor data, machine learning algorithms, and cloud-based computing. The project is funded by the National Aeronautics and Space Administration (NASA) with supplemental funding from the United States Geological Survey (USGS). The project is led by USGS and carried out in collaboration with NASA AMES, University of New Hampshire (UNH), California State University Monterey Bay (CSUMB), University of Wisconsin (UW), NASA GSFC, and Northern Arizona University (NAU). There were a number of International partners, including The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

This document provides data characteristics and user guidelines for the GFSAD30 cropland extent product for the North American continent (GFSAD30NACE). The Coordinate Reference System (CRS) used for the GFSAD30NACE is a geographic coordinate system (GCS) based on the World Geodetic System 1984 (WGS84) reference ellipsoid. The cropland extent data are provided in GeoTIFF raster tiles.

1.1 Background

Accurate spatial information on croplands is critical for global food security research, agricultural planning, and land-cover change studies (Foley et al. 2011; Thenkabail et al. 2010). Satellite image-based cropland maps provide spatially explicit, economic, and efficient methods and opportunities for cropland monitoring (Yu et al., 2013, Foley et al., 2011; Fritz et al., 2015; Wardlow and Egbert, 2008). North America provides much of the global crop production in the world at approximately 30%. It is the largest producer of maize, and the third largest producer of wheat (Cerquiglini et al., 2016). A fundamental description of food production and food security as well as an indicator of the food supply system health are achieved by mapping and quantifying the spatial extent of croplands and can be used for economic and policy decision making (Foley et al., 2011; Thenkabail et al., 2009).

The current cropland maps and extents for North America, including the Central American countries, the Caribbean, and Hawaii, however, have significant shortcomings including: 1) coarse spatial resolution (250m pixels or larger), 2) low overall accuracies, and 3) large inconsistencies in spatial distribution of croplands among current maps at various international level in North America. We address these shortcomings in this study by providing a comprehensive and consistent cropland extent map across the entire North American continent using 30m spatial resolution for the nominal year 2010.

We leveraged the computing capacity of Google's Earth Engine (GEE - Gorelick et al., 2017) in conjuction with the Landsat 5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper (ETM+) data archive in this study to classify cropland extent at the North American continental scale. We used a random forest classification on GEE to develop a pixel-based classification of the North American continental cropland extent. We then fused the pixel-based classification with crop field boundaries across the North American continent identified using recursive hierarchical segmentation (RHSeg) (Tilton et al., 2012), an object-based classification method on Northern Arizona University (NAU)'s high performance computing cluster Monsoon. The fusion approach removed spatial uncertainties such as the 'salt and pepper' effect noise and partially classified crop fields. This fusion of the two approaches resulted in an unprecedented cropland extent map at 30 m spatial resolution for the North American continent for the nominal year 2010. We validated the final fusion-based cropland extent map using United States Department of Agriculture (USDA) Cropland Data Layer (CDL) for the United States, Agriculture and Agri-food Canada (AAFC) Annual Crop Inventory (ACI) in Canada, Servicio de Información Agroalimentaria y Pesquera (SIAP)'s digitized agricultural boundaries in Mexico, and high-resolution images from GEE's application programming interface (API). Additionally, we validated the cropland extent map using USDA county crop statistics data, AAFC agricultural census data, and agricultural statistics from other countries in North America.

Detailed description of the satellite and reference data, processing scheme, approaches, methods, results, and conclusions is provided in the algorithm theoretical basis document (ATBD) for GFSAD30NACE.

2 Dataset Characteristics

Global food security-support analysis data at 30m cropland extent for the North American continent (GFSAD30NACE) V001 data and characteristics are described below:

2.1 Global Food Security Support Analysis Data (GFSAD) 30-m V001

2.1.1 Collection Level

Short name	GFSAD30NACE
Temporal Granularity	Static
Temporal Extent	2010, nominal
Spatial Extent	North America
File size	~800 MB
Coordinate System	Geographic
Datum	WGS84
File Format	GeoTIFF

2.1.2 Granule Level

Number of Layers	1
Columns/Rows	307053 × 272312
Pixel Size	~ 30m

2.1.3 Data Layer Characteristics

SDS Layer Name	Description	Units	Data Type	Fill Value	Valid Range	Scale Factor
Band 1	Crop Extent for North America	N/A	8-bit unsigned integer	N/A	0,1,2	N/A

2.1.4 Data Layers Classification

Class Label	Class Name	Description
0	Water	Water bodies / no-data
1	Non-Cropland	Non-Cropland areas *
2	Cropland	Cropland areas #

Cropland areas include cultivated land with plants harvested for food, feed, and fiber (e.g., wheat, rice, corn, soybeans, cotton) and continuous plantations (e.g., coffee, tea, rubber, cocoa, and oil palms)

* Non-cropland areas include classes such as bare ground, forest, etc.

2.1.5 Filename Convention

GFSAD30NACE_2010_N20E10_001_2017001121526.tif

GFSAD30NACE = Product short name

30 = 30m Resolution

NA = North America

CE = Crop Extent

2010 = Nominal Year

N20W10 = 10 × 10 degree grid, starting at (N70, W180)

001 = Version

2017001121526 = Processing Date in YYYYJJJHHMMSS

3 Dataset knowledge

3.1 Frequently Asked Questions

What does the GFSAD30NACE product contain?

This product provides cropland extent for the continental North America at nominal 30m. It covers all North American countries and 11 independent territories. The countries and regions include Canada, the US, Mexico, Guatemala, Belize, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Antigua & Barbuda, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Saint Kitts & Nevis, Saint Lucia, Saint Vincent & the Grenadines. The dependent territories in the Caribbean include: Anguilla, British Virgin Islands, Montserrat, Puerto Rico, United States Virgin Islands, Guadeloupe, Saba, Saint Barthelemy, Saint Martin, Sint Eustatius, and Sint Marteen.

What is the accuracy of the cropland extent product?

For the entire North American continent, the overall weighted accuracy of the cropland extent is 93.4% with weighted producer's accuracy of 85.4% (errors of omissions 14.6%) and weighted user's accuracy of 74.5% (errors of commissions 25.5%) for the cropland class. See the ATBD for further detailed, zone by zone discussions on accuracies.

What is the definition of the crop extent?

For the entire Global Food Security-Support Analysis Data project at 30-m (GFSAD30) project, cropland extent was defined as: "lands cultivated with plants harvested for food, feed, and fiber, include both seasonal crops (e.g., wheat, rice, corn, soybeans, cotton, alfalfa, other hay) and continuous plantations (e.g., coffee, tea, rubber, cocoa, oil palms). Cropland fallows are lands uncultivated during a season or a year but are farmlands and are equipped for cultivation, including plantations (e.g., orchards, vineyards, coffee, tea, rubber" (Teluguntla et al., 2015). Cropland extent includes all planted crops and fallowed lands. Non-croplands include all other land cover classes (such as bare ground, forest, water, etc.).

How to access the dataset?

All the GFSAD30 products will be downloadable through Land Processes Distributed Active Archive Center (LP DAAC). GFSAD30NACE, divided into 10 degree × 10 degree grids, is among them.

Can I access the dataset through Google Earth Engine (GEE)?

No. Not at this time. PI (Prasad S. Thenkabail) will determine this later.

4 Dataset Access (Applicable data tools)

The GFSAD30NACE dataset is available through the LP DAAC Data Pool and NASA Earthdata Search. GFSAD data visualization and information can also be found at Global Croplands website: Croplands.org.

5 Contact Information

LP DAAC User Services
U.S. Geological Survey (USGS)
Center for Earth Resources Observation and Science (EROS)
47914 252nd Street
Sioux Falls, SD 57198-0001

Phone Number: 605-594-6116
Toll Free: 866-573-3222 (866-LPE-DAAC)
Fax: 605-594-6963

Email: lpdaac@usgs.gov
Web: https://lpdaac.usgs.gov

For the Principal Investigators, feel free to write to:

Prasad S. Thenkabail at pthenkabail@usgs.gov

For North America cropland extent, feel free to write to:
Richard Massey rm885@nau.edu
Temuulen Sankey Temuulen.Sankey@nau.edu

More details about the GFSAD project and products can be found at: **globalcroplands.org**

6 Citations

6.1 GFSAD30NACE

Massey, R., Sankey, T.T., Yadav, K., Congalton, R.G., Tilton, J.C., Thenkabail, P.S. (2017). *NASA Making Earth System Data Records for Use in Research Environments (MEaSUREs) Global Food Security-support Analysis Data (GFSAD) Cropland Extent 2010 North America 30 m V001* [Data set]. NASA EOSDIS Land Processes DAAC. doi: 10.5067/MEaSUREs/GFSAD/GFSAD30NACE.001

7 Publications

The following publications are related to the development of the above croplands products:

7.1 Peer-reviewed publications specific to this study

Massey, R., Sankey, T.T., Yadav, K., Congalton, R.G., Tilton, J.C., Thenkabail, P.S., (2017). Landsat-derived North American continental-scale cropland extent classification using high performance computing platforms. In preparation.

Massey, R., Sankey, T.T., Congalton, R.G., Yadav, K., Thenkabail, P.S., Ozdogan, M., Sánchez Meador, A.J. 2017. MODIS phenology-derived, multi-year distribution of conterminous U.S. crop types, Remote Sensing of Environment, Volume 198, 1 September 2017, Pages 490-503, ISSN 0034-4257, https://doi.org/10.1016/j.rse.2017.06.033.

7.2 Peer-reviewed publications within GFSAD project

Congalton, R.G., Gu, J., Yadav, K., Thenkabail, P.S., and Ozdogan, M. 2014. Global Land Cover Mapping: A Review and Uncertainty Analysis. Remote Sensing Open Access Journal. Remote Sens. 2014, 6, 12070-12093; http://dx.doi.org/10.3390/rs61212070.

Congalton, R.G, 2015. Assessing Positional and Thematic Accuracies of Maps Generated from Remotely Sensed Data. Chapter 29, In Thenkabail, P.S., (Editor-in-Chief), 2015. "Remote Sensing Handbook" Volume I: Volume I: Data Characterization, Classification, and Accuracies: Advances of Last 50 Years and a Vision for the Future. Taylor and Francis Inc.\CRC Press, Boca Raton, London, New York. Pp. 900+. In Thenkabail, P.S., (Editor-in-Chief), 2015. "Remote Sensing Handbook" Volume I: **Remotely Sensed Data Characterization, Classification, and Accuracies**. Taylor and Francis Inc.\CRC Press, Boca Raton, London, New York. ISBN 9781482217865 - CAT# K22125. Print ISBN: 978-1-4822-1786-5; eBook ISBN: 978-1-4822-1787-2. Pp. 678.

Gumma, M.K., Thenkabail, P.S.,Teluguntla, P., Rao, M.N., Mohammed, I.A., and Whitbread, A.M. 2016. Mapping rice-fallow cropland areas for short-season grain legumes intensification in South Asia using MODIS 250 m time-series data. International Journal of Digital Earth, http://dx.doi.org/10.1080/17538947.2016.1168489

Massey, R., Sankey, T.T., Congalton, R.G., Yadav, K., Thenkabail, P.S., Ozdogan, M., Sánchez Meador, A.J. 2017. MODIS phenology-derived, multi-year distribution of conterminous U.S. crop types, Remote Sensing of Environment, Volume 198, 1 September 2017, Pages 490-503, ISSN 0034-4257, https://doi.org/10.1016/j.rse.2017.06.033.

Phalke, A. R., Ozdogan, M., Thenkabail, P. S., Congalton, R. G., Yadav, K., & Massey, R. et al. (2017). A Nominal 30-m Cropland Extent and Areas of Europe, Middle-east, Russia and Central Asia for the Year 2015 by Landsat Data using Random Forest Algorithms on Google Earth Engine Cloud. (in preparation).

Teluguntla, P., Thenkabail, P.S., Xiong, J., Gumma, M.K., Congalton, R.G., Oliphant, A., Poehnelt, J., Yadav, K., Rao, M., and Massey, R. 2017. Spectral matching techniques (SMTs) and automated cropland classification algorithms (ACCAs) for mapping croplands of Australia using MODIS 250-m time-series (2000–2015) data, International Journal of Digital Earth.

DOI:10.1080/17538947.2016.1267269.IP-074181,
http://dx.doi.org/10.1080/17538947.2016.1267269.

Teluguntla, P., Thenkabail, P., Xiong, J., Gumma, M.K., Giri, C., Milesi, C., Ozdogan, M., Congalton, R., Yadav, K., 2015. CHAPTER 6 - Global Food Security Support Analysis Data at Nominal 1 km (GFSAD1km) Derived from Remote Sensing in Support of Food Security in the Twenty-First Century: Current Achievements and Future Possibilities, in: Thenkabail, P.S. (Ed.), Remote Sensing Handbook (Volume II): Land Resources Monitoring, Modeling, and Mapping with Remote Sensing. CRC Press, Boca Raton, London, New York., pp. 131–160. Link.

Xiong, J., Thenkabail, P.S., Tilton, J.C., Gumma, M.K., Teluguntla, P., Oliphant, A., Congalton, R.G., Yadav, K. 2017. A Nominal 30-m Cropland Extent and Areas of Continental Africa for the Year 2015 by Integrating Sentinel-2 and Landsat-8 Data using Random Forest, Support Vector Machines and Hierarchical Segmentation Algorithms on Google Earth Engine Cloud. Remote Sensing Open Access Journal (in review).

Xiong, J., Thenkabail, P.S., Gumma, M.K., Teluguntla, P., Poehnelt, J., Congalton, R.G., Yadav, K., Thau, D. 2017. Automated cropland mapping of continental Africa using Google Earth Engine cloud computing, ISPRS Journal of Photogrammetry and Remote Sensing, Volume 126, April 2017, Pages 225-244, ISSN 0924-2716, https://doi.org/10.1016/j.isprsjprs.2017.01.019.

7.3 Web sites and Data portals:

http://croplands.org (30-m global croplands visualization tool)
http://geography.wr.usgs.gov/science/croplands/index.html (GFSAD30 web portal and dissemination)
http://geography.wr.usgs.gov/science/croplands/products.html#LPDAAC (dissemination on LP DAAC)
http://geography.wr.usgs.gov/science/croplands/products.html (global croplands on Google Earth Engine)
croplands.org (crowdsourcing global croplands data)

7.4 Other relevant past publications prior to GFSAD project

Biggs, T., Thenkabail, P.S., Krishna, M., GangadharaRao Rao, P., and Turral, H., 2006. Vegetation phenology and irrigated area mapping using combined MODIS time-series, ground surveys, and agricultural census data in Krishna River Basin, India. International Journal of Remote Sensing. 27(19):4245-4266.

Biradar, C.M., Thenkabail, P.S., Noojipady, P., Yuanjie, L., Dheeravath, V., Velpuri, M., Turral, H., Gumma, M.K., Reddy, O.G.P., Xueliang, L. C., Schull, M.A., Alankara, R.D., Gunasinghe, S., Mohideen, S., Xiao, X. 2009. A global map of rainfed cropland areas (GMRCA) at the end of last millennium using remote sensing. International Journal of Applied Earth Observation and Geoinformation. 11(2). 114-129. doi:10.1016/j.jag.2008.11.002. January, 2009.

Dheeravath, V., Thenkabail, P.S., Chandrakantha, G, Noojipady, P., Biradar, C.B., Turral. H., Gumma, M.1, Reddy, G.P.O., Velpuri, M. 2010. Irrigated areas of India derived using MODIS 500m data for years 2001-2003. ISPRS Journal of Photogrammetry and Remote Sensing. http://dx.doi.org/10.1016/j.isprsjprs.2009.08.004. 65(1): 42-59.

Thenkabail, P.S. 2012. Special Issue Foreword. Global Croplands special issue for the August 2012 special issue for Photogrammetric Engineering and Remote Sensing. PE&RS. 78(8): 787-788.Thenkabail, P.S. 2012. Guest Editor for Global Croplands Special Issue. Photogrammetric Engineering and Remote Sensing. PE&RS. 78(8).

Thenkabail, P.S., Biradar C.M., Noojipady, P., Cai, X.L., Dheeravath, V., Li, Y.J., Velpuri, M., Gumma, M., Pandey, S. 2007a. Sub-pixel irrigated area calculation methods. Sensors Journal (special issue: Remote Sensing of Natural Resources and the Environment (Remote Sensing SensorsEdited by Assefa M. Melesse). 7:2519-2538. http://www.mdpi.org/sensors/papers/s7112519.pdf.

Thenkabail, P.S., Biradar C.M., Noojipady, P., Dheeravath, V., Li, Y.J., Velpuri, M., Gumma, M., Reddy, G.P.O., Turral, H., Cai, X. L., Vithanage, J., Schull, M., and Dutta, R. 2009a. Global irrigated area map (GIAM), derived from remote sensing, for the end of the last millennium. International Journal of Remote Sensing. 30(14): 3679-3733. July, 20, 2009.

Thenkabail, P.S., Biradar, C.M., Turral, H., Noojipady, P., Li, Y.J., Vithanage, J., Dheeravath, V., Velpuri, M., Schull M., Cai, X. L., Dutta, R. 2006. An Irrigated Area Map of the World (1999) derived from Remote Sensing. Research Report # 105. International Water Management Institute. Pp. 74. Also, see under documents in: http://www.iwmigiam.org.

Thenkabail, P. S.; Dheeravath, V.; Biradar, C. M.; Gangalakunta, O. P.; Noojipady, P.; Gurappa, C.; Velpuri, M.; Gumma, M.; Li, Y. 2009b. Irrigated Area Maps and Statistics of India Using Remote Sensing and National Statistics. Journal Remote Sensing. 1:50-67. http://www.mdpi.com/2072-4292/1/2/50.

Thenkabail, P.S., GangadharaRao, P., Biggs, T., Krishna, M., and Turral, H., 2007b. Spectral Matching Techniques to Determine Historical Land use/Land cover (LULC) and Irrigated Areas using Time-series AVHRR Pathfinder Datasets in the Krishna River Basin, India. Photogrammetric Engineering and Remote Sensing. 73(9): 1029-1040. (Second Place Recipients of the 2008 John I. Davidson ASPRS President’s Award for Practical papers).

Thenkabail, P.S., Hanjra, M.A., Dheeravath, V., Gumma, M.K. 2010. A Holistic View of Global Croplands and Their Water Use for Ensuring Global Food Security in the 21st Century through Advanced Remote Sensing and Non-remote Sensing Approaches. Remote Sensing open access journal. 2(1):211-261. doi:10.3390/rs2010211. http://www.mdpi.com/2072-4292/2/1/211

Thenkabail P.S., Knox J.W., Ozdogan, M., Gumma, M.K., Congalton, R.G., Wu, Z., Milesi, C., Finkral, A., Marshall, M., Mariotto, I., You, S. Giri, C. and Nagler, P. 2012. Assessing future risks to agricultural productivity, water resources and food security: how can remote sensing help?

Photogrammetric Engineering and Remote Sensing, August 2012 Special Issue on Global Croplands: Highlight Article. 78(8): 773-782.

Thenkabail, P.S., Schull, M., Turral, H. 2005. Ganges and Indus River Basin Land Use/Land Cover (LULC) and Irrigated Area Mapping using Continuous Streams of MODIS Data. Remote Sensing of Environment. Remote Sensing of Environment, 95(3): 317-341.

Velpuri, M., Thenkabail, P.S., Gumma, M.K., Biradar, C.B., Dheeravath, V., Noojipady, P., Yuanjie, L.,2009. Influence of Resolution or Scale in Irrigated Area Mapping and Area Estimations. Photogrammetric Engineering and Remote Sensing (PE&RS). 75(12): December 2009 issue.

7.5 Books and Book Chapters

Teluguntla, P., Thenkabail, P.S., Xiong, J., Gumma, M.K., Giri, C., Milesi, C., Ozdogan, M., Congalton, R.,Tilton, J.,Sankey,T.R., Massey, R., Phalke, A., and Yadav, K. 2015. Global Food Security Support Analysis Data at Nominal 1 km (GFSAD1 km) Derived from Remote Sensing in Support of Food Security in the Twenty-First Century: Current Achievements and Future Possibilities, Chapter 6. In Thenkabail, P.S., (Editor-in-Chief), 2015. “Remote Sensing Handbook” (Volume II): Land Resources Monitoring, Modeling, and Mapping with Remote Sensing. Taylor and Francis Inc. Press, Boca Raton, London, New York. ISBN 9781482217957 - CAT# K22130. Pp. 131-160

Biradar, C.M., Thenkabail. P.S., Noojipady, P., Li, Y.J., Dheeravath, V., Velpuri, M., Turral, H., Cai, X.L., Gumma, M., Gangalakunta, O.R.P., Schull, M., Alankara, R.D., Gunasinghe, S., and Xiao, X. 2009. Book Chapter 15: Global map of rainfed cropland areas (GMRCA) and stastistics using remote sensing. Pp. 357-392. In the book entitled: “Remote Sensing of Global Croplands for Food Security” (CRC Press- Taylor and Francis group, Boca Raton, London, New York. Pp. 475. Published in June, 2009. (Editors: Thenkabail. P., Lyon, G.J., Biradar, C.M., and Turral, H.).

Gangalakunta, O.R.P., Dheeravath, V., Thenkabail, P.S., Chandrakantha, G., Biradar, C.M., Noojipady, P., Velpuri, M., and Kumar, M.A. 2009. Book Chapter 5: Irrigated areas of India derived from satellite sensors and national statistics: A way forward from GIAM experience. Pp. 139-176. In the book entitled: “Remote Sensing of Global Croplands for Food Security” (CRC Press- Taylor and Francis group, Boca Raton, London, New York. Pp. 475. Published in June, 2009. (Editors: Thenkabail. P., Lyon, G.J., Biradar, C.M., and Turral, H.).

Li, Y.J., Thenkabail, P.S., Biradar, C.M., Noojipady, P., Dheeravath, V., Velpuri, M., Gangalakunta, O.R., Cai, X.L. 2009. Book Chapter 2: A history of irrigated areas of the world. Pp. 13-40. In the book entitled: “Remote Sensing of Global Croplands for Food Security” (CRC Press- Taylor and Francis group, Boca Raton, London, New York. Pp. 475. Published in June, 2009. (Editors: Thenkabail. P.,Lyon, G.J., Biradar, C.M., and Turral, H.).

Thenkabail, P.S., Lyon, G.J., and Huete, A. 2011. Book Chapter # 1: Advances in Hyperspectral Remote Sensing of Vegetation. In Book entitled: “Remote Sensing of Global Croplands for Food

Security" (CRC Press- Taylor and Francis group, Boca Raton, London, New York. Edited by Thenkabail, P.S., Lyon, G.J., and Huete, A. Pp. 3-38.

Thenkabail. P.S., Biradar, C.M., Noojipady, P., Dheeravath, V., Gumma, M., Li, Y.J., Velpuri, M., Gangalakunta, O.R.P. 2009c. Book Chapter 3: Global irrigated area maps (GIAM) and statistics using remote sensing. Pp. 41-120. In the book entitled: "Remote Sensing of Global Croplands for Food Security" (CRC Press- Taylor and Francis group, Boca Raton, London, New York. Pp. 475. Published in June, 2009. (Editors: Thenkabail. P., Lyon, G.J., Biradar, C.M., and Turral, H.).

Thenkabail. P., Lyon, G.J., Turral, H., and Biradar, C.M. (Editors) 2009d. Book entitled: "Remote Sensing of Global Croplands for Food Security" (CRC Press- Taylor and Francis group, Boca Raton, London, New York. Pp. 556 (48 pages in color). Published in June, 2009. Reviews of this book: http://www.crcpress.com/product/isbn/9781420090093 http://gfmt.blogspot.com/2011/05/review-remote-sensing-of-global.html

Thenkabail, P.S. and Lyon, J.G. 2009. Book Chapter 20: Remote sensing of global croplands for food security: way forward. Pp. 461-466. In the book entitled: "Remote Sensing of Global Croplands for Food Security" (CRC Press- Taylor and Francis group, Boca Raton, London, New York. Pp. 475. Published in June, 2009. (Editors: Thenkabail. P., Lyon, G.J., Biradar, C.M., and Turral, H.).

Turral, H., Thenkabail, P.S., Lyon, J.G., and Biradar, C.M. 2009. Book Chapter 1: Context, need: The need and scope for mapping global irrigated and rain-fed areas. Pp. 3-12. In the book entitled: "Remote Sensing of Global Croplands for Food Security" (CRC Press- Taylor and Francis group, Boca Raton, London, New York. Pp. 475. Published in June, 2009. (Editors: Thenkabail. P., Lyon, G.J., Biradar, C.M., and Turral, H.).