

Capacity development  
training workshop on  
crop simulation  
modelling and effects of  
climate risks on  
agricultural production  
systems in Southeast  
Asia

CBA2018-04MY-Geetha

2023



**Project Reference Number:** CBA2018-04MY-Geetha

**Project Duration:** 2 years

**Funding Awarded:** 80,000

**Grant DOI:**

**Date of Publication:** 28 April, 2023

**Project Leader and Contact Details:** Prof. Geetha Mohan, University of Toyama, Japan  
([geetha@eco.u-toyama.ac.jp](mailto:geetha@eco.u-toyama.ac.jp))

**Collaborators and Contact Details:**

- Prof. Gerrit Hoogenboom, University of Florida, USA ([gerrit@ufl.edu](mailto:gerrit@ufl.edu))
- Prof. Attachai Jintrawet, Chiang Mai University, Thailand ([attachai.j@cmu.ac.th](mailto:attachai.j@cmu.ac.th))
- Dr. Chitnucha Buddhaboorn, Ministry of Agriculture and Cooperatives, Thailand  
([chitnucha.b@rice.mail.go.th](mailto:chitnucha.b@rice.mail.go.th))
- Prof. Thi Lang Ngyuyen, High Agricultural Technology Research Institute for Mekong Delta, Vietnam ([ntlang.prof@gmail.com](mailto:ntlang.prof@gmail.com))
- Dr. Nareth Nut, Royal University of Agriculture, Cambodia ([nnareth@rua.edu.kh](mailto:nnareth@rua.edu.kh))
- Dr. Sithong Thongmanivong, National University of Laos, Lao PDR  
([sithong@nuol.edu.la](mailto:sithong@nuol.edu.la))
- Prof. Hirotaka Matsuda, Tokyo University of Agriculture, Japan  
([hiro.matsu0825@gmail.com](mailto:hiro.matsu0825@gmail.com))
- Prof. Sukri Banua Irwan, Universitas Lampung, Indonesia ([irwanbanuwa@yahoo.com](mailto:irwanbanuwa@yahoo.com))

**Recommended Citation:**

Mohan, G., Hoogenboom, G., Buddhaboorn, C., Ngyuyen, L.T., Nut, N., Thongmanivong, S., Matsuda, H., Irwan, B.S. (2023). *Capacity Development Training Workshop on Crop Simulation Modeling and Effects of Climate Risks on Agricultural Production Systems in Southeast Asia*. Project Final Report. Asia- Pacific Network for Global Change Research.



Asia-Pacific Network for Global Change Research (APN)

© 2023 The authors. Published by the Asia-Pacific Network for Global Change Research (APN) under the Creative Commons Attribution-NonCommercial 4.0 International (CC-BY-NC 4.0) licence.

*All opinions, findings, conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of APN. While the information and advice in this publication are believed to be true and accurate at the date of publication, neither the editors nor APN accepts any legal responsibility for any errors or omissions that may be made. APN and its member countries make no warranty, expressed or implied, with respect to the material contained herein.*

*The use of geographic names, boundaries and related data on maps, and in lists and tables within this publication are not warranted to be error-free, nor do they imply any endorsement by APN*

## Appendices

### Appendix-1. Preliminary Meeting ‘Crop Simulation Modeling and Effects of Climate Risks on Agricultural Production in Southeast Asia’, March 4, 2019

A one-day inception meeting on ‘Crop Simulation Modeling and Effects of Climate Risks on Agricultural Production in Southeast Asia’ was held on March 4, 2019, at Can Tho city and jointly organized with the United Nations University Institute for the Advanced Study of Sustainability, Japan; Institute for Sustainable Food Systems, University of Florida, USA; DSSAT Foundation, USA; and High Agricultural Technology Research Institute for Mekong Delta (HATRI), Vietnam. All the collaborative project members: Dr. Geetha Mohan, Japan; Prof. Gerrit Hoogenboom, USA; Dr. Chitnucha Buddhaboont, Thailand; Prof. Dr. Ir. Irwan Sukri Banuwa, Prof. Dr. Udin Hasanudin, Dr. Abdullah Aman from Indonesia; Prof. N.T.Lang, Vietnam, attended the meeting and discussed the planning and implementation of the training workshop, including the target groups, data sharing, and dissemination of the training outcomes through reports, policy briefs etc.



Preliminary meeting Group Picture

Presentation by Prof. NT Lang, Vietnam

Prof. N.T. Lang made the opening remarks and shared the “Vietnamese farmer's experiences over the *past 35 years of adapting to the changing environmental conditions by modifying and diversifying their production systems and water management. But the recent and forecasted agro-hydrological changes threaten the viability of these farming and social systems and, subsequently, food security in Vietnam. Some significant constraints that limit the farmers' ability to adapt strategies include the availability of suitable cultivars, soil nutrient management options, etc. However, the need for more information on potential threats from climate change, climate variability, soil carbon sequestration and other environmental sustainability has become vital for improved crop production. Therefore, crop simulation models are essential to advancing our understanding of the developments that determine crop responses and predicting crop performance, resource use and environmental impacts for different environmental and management scenarios.*”



**Presentation by Dr. Geetha Mohan at Can Tho, Vietnam      Presentation by Prof. Irwan at Can Tho, Vietnam**

Following the open remarks, Dr. Geetha Mohan, the project leader, provided the members with an overview of the project's objectives and the execution of the project plan. Each project member then discussed their respective country's agricultural situation and challenges. In particular, Professor N.T. Lang from Vietnam emphasized efforts to focus on the advanced collection and evaluation of local germplasm to identify landraces with greater submergence tolerance under salt and drought stress. She also highlighted the involvement of young scientists, particularly women, in

strengthening the seed multiplication system and cropping system model training on innovative rice management of new flood varieties. During the preliminary meeting, Dr. Chitnucha from Thailand and Prof. Irwan from Indonesia discussed various agriculture and climate change issues. These included risk analysis, land price distortions, poor infrastructure, the impact of seasonal climate forecasts, and the development of effective adaptation measures, such as new crop varieties, to cope with climate risks. The meeting was concluded by Prof. Bui Chi Buu from Vietnam (Appendix-A).



**Project team visited at AGRICAM, Can Tho**



**Project team visited at AGRICAM, Can Tho**

Dr. Sithong Thongmanivong from Lao PDR, Mr. Nut Nareth from Cambodia, and Dr. Hirotaka Matsuda from Japan were unable to attend the meeting. During the afternoon session, all project members visited the nearest rice manufacturing company, 'AGRICAM' (<http://www.agricam.com.vn/>), to gather information on the most prominent rice varieties produced in nearby villages, as well as the farmers' preferred varieties. This visit is expected to provide valuable insights into the local context, enabling the project members to develop effective adaptation measures to address the challenges of climate change in agriculture.



## **Appendix-2. First Training Workshop on 'Crop Simulation Modelling and Effects of Climate Risks on Agricultural Production Systems in Vietnam', Can Tho, Vietnam, March 5-9, 2019.**

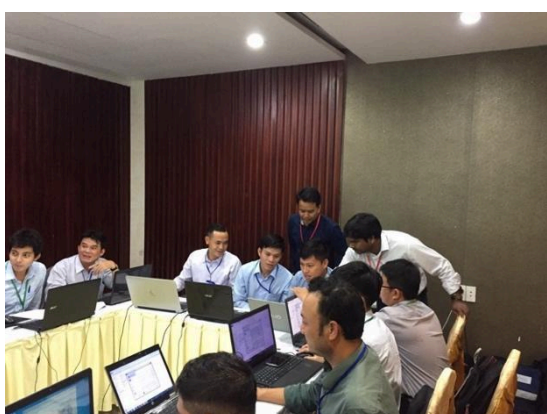
An extensive five-day training workshop on 'Crop Simulation Modelling and the Effects of Climate Risks on Agricultural Production Systems in Vietnam' was held from March 05 to 09, 2019. The workshop was attended by a total of twenty-one participants from thirteen provinces, including Ca Mau, Hau Giang, Soc Trang, Long An, Kein Giang, An Giang, Ben Tre, Tay Ninh, Tien Giang, Vinh Long, Can Tho, Bac Lieu, and Dong Thap, all of whom were young and dynamic researchers, academicians, scientists, engineers, and extension officers from government institutes, universities, and organizations (please see the list of participants in Appendix-2.1). The five-day training workshop included the installation procedure of the DSSAT software, lectures, and practical exercises (please refer to Appendix-B). All participants actively learned about the DSSAT software and crop simulation models with worked-out examples. On the final day, the participants were awarded completion certificates for the course.



Group photo, DSSAT training at Can Tho



Participants at DSSAT training at Can Tho



Exercise Session, DSSAT training at Can Tho



Certificate Ceremony, DSSAT training at Can Tho

On the workshop's concluding day, we visited Binh Thuy and O Mon districts to meet with a group of farmers and observe their rice crop fields. All participants were present for this informative session, providing an excellent opportunity for knowledge-sharing between the farmers and scientists. The farmers had concerns about improving their yield gaps, especially during drought and flood seasons. Some scientists addressed their questions and suggested using tolerant varieties capable of coping with these challenging conditions. Farmers emphasized the importance of conducting rice value chain analysis with rice millers and traders, who are equally important players. They also highlighted the need for technology packages for the new varieties and management practices to address their challenges.



**Farmers field visit, Omon District, Vietnam**

**Scientists and farmers interaction session, Vietnam**

At the end of the session, Prof. N T Lang summarised the farmers' interaction session and identified the major constraints in agricultural production in the Mekong Delta. These constraints include low yields in irrigated lowlands, biotic stresses such as sheath blight, blast, bacterial blight, brown plant hopper, stem borer, thrips, leaf-folder, and abiotic stresses like acid sulphate soils, salinity, drought, and heat tolerance. Additionally, the lack of varieties resistant to biotic and abiotic stresses, low yields in hybrid rice, and poor grain quality of inbred compounds these challenges. In response, Prof. Lang highlighted the limited market access for new varieties and the weak extension system.



### **Appendix-3. Second Training Workshop on `Efficient and Precision Agricultural Resource Utilization under Changes with Simulation Models and GIS', Chiang Mai, Thailand, August 19-24, 2019.**

An International Training Workshop, "Efficient and Precision Agricultural Resource Utilization under Changes with Simulation Models and GIS", was successfully organized in Chiang Mai, Thailand, from August 19 to 24, 2019. The workshop, jointly organized by Chiang Mai University, the University of Florida, the DSSAT Foundation, and the United Nations University Institute for the Advanced Study of Sustainability, aimed to improve participants' understanding of simulation models in predicting interactions of agricultural resources such as water and nitrogen etc. The workshop attracted 20 high-quality participants, including 15 young participants from rice research departments, universities, and the land development department in Thailand who were supported and funded by the APN project, of whom 11 were females and four were males (Annexure 3.1).



**Group photo, DSSAT training at Chiang Mai, Thailand**

**Exercise Session, DSSAT training at Chiang**

During the six-day workshop, six instructors from Japan, Thailand, and the USA facilitated the workshop and topics covered, including Introduction & Potential Crop Production; Weather and Crop Genetic Coefficients; Water-limited Crop Production and Soils data; Nitrogen-limited Crop Production and Experimental data; Evaluating Risk and Sustainability applications; as well as Sequential and Spatial applications

(Appendix-B). A detailed programme agenda for the training can find it on the dedicated website (<https://www.carsr.agri.cmu.ac.th/training/dssat2019/>).

All the participants received hard and soft copies of various training materials, including a well-documented book, software tools, lectures, computer exercises, and references. While the workshop was conducted in English, many Thai participants suggested that future workshops for Thai participants be conducted in Thai, with DSSAT manuals and exercises available. They also recommended organizing a series of workshops for beginner, intermediate, and advanced levels.

Several participants proposed developing a dynamic model and user interface for studying plant nutrients, pests, and climate change, which could be accomplished through a Public-Private Partnership scheme. The most significant achievement of the workshop was the enthusiasm expressed by all participants to encourage their colleagues to use the tools and set up their experiments to run crop simulations, demonstrating their commitment to the advancement of the field. They further expressed their eagerness to encourage their colleagues to use the tools and implement field experiments based on the DSSAT manuals. They also indicated their willingness to contribute their datasets to the system.

#### **Appendix-4. Third and Final Training Workshop on `Crop Simulation Modeling and Effects of Climate Risks on Agricultural Production Systems in Southeast Asia`, Bangkok, Thailand, January 9-14, 2023.**

The University of Toyama collaborated with the University of Florida, the DSSAT Foundation, and the Asia Pacific Network for Global Change Research (APN-GCR) to organize a six-day training workshop on Crop Simulation Modeling and the Effects of Climate Risks on Agricultural Production Systems in Southeast Asia. The workshop was held in Bangkok, Thailand, from January 9th to 14th, 2022. The primary objective of the training program was to equip participants with a better understanding of simulation models and their application in predicting the effects of weather and climate conditions on agricultural resources, such as water and nitrogen, and their impact on crop phenology, growth, and yield. The training program also aimed to teach participants how to use the DSSAT-CSM model to enhance the management of cropping systems and improve crop simulation models such as CROPGRO and CERES. Additionally, the workshop facilitated the co-design of a network of system approach teams in Southeast Asia.

Over six days, participants engaged in a rigorous training program that covered various topics, including the installation of the latest DSSAT 4.8 version software, lectures, and practical exercises on potential crop production, weather and crop genetic coefficients, water-limited production, soils, experimental dataset, nitrogen-limited crop production, evaluation of risk and sustainability, and model application and next steps (Appendix-B). The workshop also featured an e-book titled "Understanding Options for Agricultural Production." The program welcomed twenty-one participants from Cambodia (7), Indonesia (7), Lao PDR (6), and Thailand (1), who were selected through a merit-based advertising system consisting of seven female and fourteen male participants (Appendix 4.1). The group included academicians, young researchers, students, and extension officers from Southeast Asian countries who are actively working on agriculture, plant breeding, agroforestry, and hydrological issues. The diverse group of participants and their backgrounds contributed to a rich and engaging learning experience, and the training program successfully provided them with the tools necessary to improve the management of cropping systems and develop more sustainable and resilient agricultural production systems in Southeast Asia.

Professor Geetha Mohan introduced the project and outlined the expected outcomes of the training program. He shared the vision and objectives of the project, which was to develop a systems approach that could enhance the resilience of Southeast Asian agricultural production systems to climate risks. He highlighted the importance of



simulation models in predicting the effects of climate change on crop production and the significance of the DSSAT-CSM model in achieving the project's goals.



**Prof. Geetha Mohan briefing the project aims and purposes of the training.**

He elaborated on the expected outcomes of the training program, which included equipping the participants with practical knowledge and skills in simulation modelling, enhancing their understanding of the relationships between agricultural resources and weather and climate conditions, and improving their ability to manage cropping systems effectively. The training program aimed to empower the participants with the tools necessary to apply the DSSAT-CSM model in their local contexts to develop more resilient agricultural production systems.

Furthermore, he emphasized that the project's ultimate goal was to establish a network of system approach teams in Southeast Asia to facilitate collaboration and knowledge-sharing among researchers and practitioners in the region. Through this network, the project aimed to foster a culture of innovation and learning that could drive sustainable agricultural development in Southeast Asia.



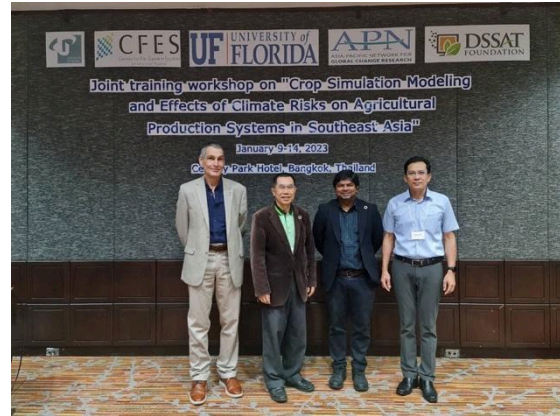
**Group picture on the day 1 of the training programme**

**Prof. Hoogenboom responding Q & A Session**

Prof. Gerrit Hoogenboom and Prof. Attachai Jintrawet are both experts in crop modelling and have contributed significantly to the development and application of DSSAT. They have introduced the DSSAT software 4.8 version and its various modules to the participants in the training. The training modules covered lectures on the minimum dataset required to run the models, including experimental data such as genetic coefficients, crop management practices, and soil and weather data. The computer exercises included potential, water-limited, and nutrient-limited production, which demonstrated how to simulate crop growth and development under different scenarios.



**Group Discussion among Participants**



**Resource persons for the DSSAT Training Workshop**

In addition, the training also covered creating crop measurement files and model evaluation, sensitivity analysis tools, and seasonal analysis. These exercises were aimed at providing participants with hands-on experience in using the DSSAT software and its various modules.



**Discussion on exercise results with Prof. Attachai**



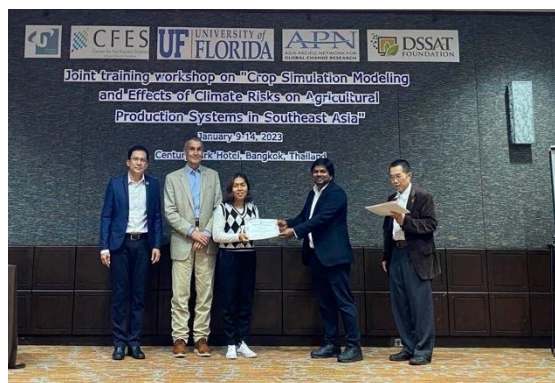
**Discussion on exercise results with Prof. Hoogenboom**

Dr. Anothai Jakarat, who is also an expert in crop modeling, demonstrated all the practical exercises to the participants in the training. This allowed participants to ask questions and receive feedback on their work, ensuring they understood the software and its application comprehensively.





**Discussion on exercise results with Dr.Jakarat**



**Certificate Awards Ceremony**



**Participants with course completion certificate**

On the last day of the training, each country representative expressed their gratitude to all the resource persons, APN Secretariat for funding their training and the organizers for providing them with such a valuable and informative learning experience and a solid foundation in the use of the DSSAT software and its various modules, enabling them to apply crop modelling techniques in their research and decision-making processes. Finally, Prof. Geetha Mohan concluded the workshop and presented the participants with certificates of successful completion.

## Appendix-A. Project Meeting on Crop Simulation Modelling and Effects of Climate Risks on Agricultural Production Systems in Southeast Asia

04 March 2019, HATRI, Can Tho City, Vietnam

<b><u>Time Slot</u></b>	<b><u>Particulars</u></b>
9:00-09:10	Registration
09:10-09:20	Welcome remarks by Prof. L T Lang
09:20-09:30	Self-Introduction by Collaborators
09:30-10:15	Project Introduction and expected outcomes by Dr. Geetha Mohan Discussions by all project members
10:15-10:30	Tea Break and Group Picture
10:30-10:50	Agricultural Situation and Challenges in Vietnam by Prof. N T Lang
10:50-11:10	Agricultural Situation and Challenges in Thailand by Dr. Chitnucha Buddhagoon
11:10-11:30	Agricultural Situation and Challenges in Cambodia by Mr. Nareth Nut
11:30-11:50	Agricultural Situation and Challenges in Indonesia by Prof. Irwan Sukri Banuwa
11:50-12:10	Agricultural Situation and Challenges in Asia by Dr. Hirotaka Matsuda (Virtual)
12:10-12:15	Remarks by Prof. Bui Chi Buu
12:15-13:00	Lunch Break
13:00-18:00	Field trip to AGRICAM

## Appendix-B. Programme Agenda of Training Workshop on `Crop Simulation Modeling and Effects of Climate Risks on Agricultural Production Systems in Southeast Asia.

### *Day-1: Introduction & Potential Crop Production*

<b><i>Time</i></b>	<b><i>Learning Activities</i></b>
08:00	Registration by G. Mohan

08:30	Welcome Remarks & Introduction of resource persons <i>by G. Hoogenboom, A. Jintrawet, J. Anothai, G. Mohan</i>
08:45	A 2-minute presentation by participants/Country's coordinators <i>by A. Jintrawet</i> Group picture
10:00	Tea Break
10:15	<b>Lecture:</b> Workshop Goals, Course Outline, Schedule <i>by G. Hoogenboom</i>
10:30	<b>Lecture:</b> History and Overview of DSSAT & Example applications <i>by G. Hoogenboom</i> <i>Reading/Reference: The IBSNAT Decade</i> <i>Uehara and Tsuji Chapter in Kluwer book, pp. 1-7</i> <i>Jones et al. Chapter in Kluwer book, pp. 157-178</i> <i>Boote et al., Int J. Agr &amp; Env Inf Sys 1(2010):41-54</i> <i>Holzworth et al., Env Modeling &amp; Software 72(2015):276-286</i> <i>Jones et al., Agric Systems 155(2017):240-254</i> <i>Hoogenboom et al., 2019, DSSAT Crop Modeling Ecosystem, Chapter</i>
11:30	Installation of DSSAT Version 4.8 Software <i>by A. Jintrawet, J. Anothai, G.Mohan</i>
11:45	<b>Demo:</b> Overview of DSSAT <i>A. Jintrawet, G. Hoogenboom</i> <i>Reading/Reference DSSAT V4 Volume 1</i> <i>Readme and Install files</i>
12:00	Lunch
13:00	Exercises: Running Crop Models in DSSAT <i>by J. Anothai, and G.Mohan, A. Jintrawet</i>
13:30	<b>Lecture:</b> Simulating Phenological Development <i>by G. Hoogenboom</i> <i>Reading/Reference:</i> <i>Boote et al. chapter in Kluwer book, pp. 99-128</i>
14:15	<b>Demo:</b> Introduction to Sensitivity Analysis Tool <i>by A.Jintrawet, G. Hoogenboom</i>
14:30	<b>Exercises:</b> to Sensitivity Analysis Tool <i>by J. Anothai, and G.Mohan, A. Jintrawet</i>

### ***Day-1: Introduction & Potential Crop Production (Continued)***

15:00	Break
15:30	<b>Lecture:</b> Simulating Basic Growth Processes <i>by G. Hoogenboom</i> <i>Reading/Reference</i> <i>Jones et al., Eur. J. Agron. 18(2003):235-265</i> <i>Boote et al. chapter in Kluwer book, pp. 99-128</i> <i>Ritchie et al. chapter in Kluwer book, pp. 79-98</i>



16:30	<b>Demo:</b> Creating FileX: Potential Crop Production <i>by A. Jintrawet, J. Anothai, G. Mohan</i> Reading/Reference: DSSAT V3.5 Volume 2-1, pp. 1-93 DSSAT V3.5 Volume 1-4, pp. 111-143 DSSAT V4.0 Volume 2, XBuild User's Guide
17:00	<b>Exercises:</b> Simulating Potential Crop Production <i>by J. Anothai, G. Mohan, A. Jintrawet</i>
18:00	Reception (TBA)
19:30	Adjourn

### ***Day-2: Weather & Crop Genetic Coefficient***

<b><i>Time</i></b>	<b><i>Learning Activities</i></b>
08:00	<b>Exercises:</b> Potential Crop Production (Continued) <i>J. Anothai, G. Mohan, A. Jintrawet</i>
08:30	Feedback on exercises and software <i>By A. Jintrawet, J. Anothai, G. Mohan, G. Hoogenboom</i>
09:00	<b>Lecture:</b> Weather Data Inputs and Utilities By G. Hoogenboom Reading/Reference: DSSAT v3.5 Volume 3-3
09:15	<b>Demo:</b> WEATHERMAN <i>By A. Jintrawet, G. Hoogenboom</i>
09:30	<b>Exercises:</b> Using WEATHERMAN <i>by J. Anothai, G. Mohan, A. Jintrawet</i>
10:15	Tea Break
10:45	<b>Lecture:</b> Minimum Data Set Concept by G. Hoogenboom Reading/Reference: <i>Hunt and Boote chapter in Kluwer book, pp. 9-40</i> <i>Hoogenboom et al., 2012, Chapter in Springer Book:9-1</i>
11:00	<b>Lecture:</b> Learning the DSSAT File System by G. Hoogenboom Reading/Reference: DSSAT V3.5 Volume 2, Chapter 1
11:15	<b>Lecture:</b> Concept of Crop Genetic Coefficients Species vs. Ecotype vs. Cultivar Coefficients by G. Hoogenboom Reading/Reference: <i>CERES-Maize Species &amp; CERES-Rice Species Definitions</i> <i>CROPGRO Species &amp; CROPGRO Cultivar Definition files</i> <i>Boote et al. chapter in Kluwer book, pp. 99-128</i> <i>Ritchie et al. chapter in Kluwer book, pp. 79-98</i>

12:00	Lunch
13:00	<b>Lecture:</b> Genetic Coefficients – CROPGRO & CERES <i>by G. Hoogenboom</i>
13:30	<b>Exercises:</b> Cultivar Sensitivity Analyses <i>by J. Anothai, G.Mohan, A. Jintrawet</i>
15:00	Break

### **Day-2: Weather & Crop Genetic Coefficients (Continued)**

15:30	<b>Lecture:</b> Estimating Genetic Coefficients, Concepts by G. Hoogenboom <i>Reading/Reference:</i> <i>Mavromatis et al., Crop Science 42(2002):76-89</i> <i>Pathak et al., Trans ASABE 50(2007):2295-2302</i> <i>DSSAT V3.5 Volume 3-4, pp. 201-233</i> <i>Boote et al., Agric. Systems 70(2001): 395-420.</i>
16:00	<b>Lecture:</b> Tools for Estimating Cultivar Coefficients by G. Hoogenboom <i>Reading/Reference</i> <i>Hunt et al. Agron. J. 85(1993):1090-1094</i> <i>Hoogenboom et al., Field Crops Research 90(2004):145-163</i> <i>Anothai et al., Field Crops Research 108(2008):169-178</i> <i>He et al., Agric. Systems 103(2010):256-264</i> <i>Jones et al. Advances in Ag. Systems Modeling 2(2011):365-393</i> <i>Buddahboon et al., J Agric Science 156(2018):482-492</i>
16:15	<b>Demo:</b> GLUE Tool <i>J. Anothai</i>
16:30	<b>Exercise:</b> Cultivar Coefficient Calibration using the GLUE Tool <i>J. Anothai, G.Mohan, A. Jintrawet</i>
17:30	Adjourn

### **Day-3: Water Limited Production, Soils & Experimental Data set**

<b>Time</b>	<b>Learning Activities</b>
08:00	Exercises: Continued <i>J. Anothai, G.Mohan, A. Jintrawet</i>
08:30	Feedback on exercises and software by <i>A. Jintrawet, J. Anothai, G. Mohan, G. Hoogenboom</i>
09:00	Lecture: Simulating Water Limited Production Soil and Flood Water Balance in Rice by G. Hoogenboom <i>Reading/Reference:</i> <i>Ritchie chapter in Kluwer book, pp. 41-54</i> <i>Lopez et al., Agric. and Forest Meteorology 243(2017):84-92</i> <i>Devkota et al., Agric. and Forest Meteorology 214-215(2015):266-280</i> <i>Dokoohaki et al., Ecohydrology &amp; Hydrobiology 17(2017):207-216</i> <i>Anothai et al., Agric. and Forest Meteorology 176(2013):64-76</i>
10:15	Break
10:45	Lecture: Soil Data Inputs and Utilities by G. Hoogenboom <i>Reading/Reference:</i> <i>DSSAT V3.5 Volume 1-3, pp. 49-90</i> <i>DSSAT V4.0 Volume 2</i> <i>Gijsman et al., Eur. J. Agron. 18(2002):75-105</i> <i>Gijsman et al., Computers and Electronics in Agric 56(2007):85-100</i> <i>Romero et al., Env. Mod &amp; Software 35(2012):163-170</i> <i>Kim et al., Computers and Electronics in Agric 154(2018):256-264</i>
11:00	Demo: Creating Soil Data Files by <i>A. Jintrawet, G. Hoogenboom</i>
11:15	Exercises: Soil Data Files and Utilities by <i>J. Anothai, G.Mohan, A. Jintrawet</i>
12:00	Lunch
13:30	Demo: Creating FileX: Water Balance On by <i>A. Jintrawet, G. Hoogenboom</i>
13:45	<b>Exercises:</b> Water Limited Production by <i>J. Anothai, G.Mohan, A. Jintrawet</i>
15:00	Break
15:30	<b>Lecture:</b> Experimental Data Collection - Model Evaluation by G. Hoogenboom <i>Reading/Reference:</i> <i>DSSAT V3.5 Volume 4-7 &amp; 4-8, pp. 203-233</i> <i>Hoogenboom et al., 2012, Chapter in Springer Book, pp. 9-18</i> <i>Kersebaum et al., Env Modeling &amp; Software 72(2015): 402-417</i>

**Day-3: Water Limited Production, Soils & Experimental Data set (Continued)**

16:15	<b>Lecture:</b> Experimental Data Files and Utilities By G. Hoogenboom <i>Reading/Reference</i> <i>Hunt et al., Agric. Systems 70(2001): 477-492</i> <i>Bostick et al., Agron. J. 96(2004): 853-856</i>
16:30	<b>Demo:</b> Creating Crop Measurement Files for Model Evaluation By J. Anothai, A.Jintrawet, G. Hoogenboom
16:45	<b>Exercises:</b> Creating Crop Measurement Files for Model Evaluation By J. Anothai, G.Mohan, A. Jintrawet
	<b>Exercises:</b> Calibration and Evaluation of the DSSAT Models Using In-season Growth Analysis Data By J. Anothai, G.Mohan, A. Jintrawet
17:30	Adjourn



#### **Day-4: Nitrogen Limited Crop Production**

<b>Time</b>	<b>Learning Activities</b>
08:00	<b>Exercises:</b> Continued <i>J. Anothai, G.Mohan, A. Jintrawet</i>
08:30	Feedback on exercises and software <i>by A. Jintrawet, J. Anothai, G. Mohan, G. Hoogenboom</i>
09:00	<b>Lecture:</b> Simulating Nitrogen Limited Production Processes in the Soil <i>by G. Hoogenboom</i> <b>Reading/Reference:</b> <i>Godwin and Singh chapter in Kluwer book, pp. 55-78</i>
10:00	<b>Lecture:</b> Simulating Nitrogen Limited Production Processes in the Plant <i>by G. Hoogenboom</i> <b>Reading/Reference:</b> <i>Bowen et al. chapter in Kluwer book, pp. 189-204</i> <i>Boote et al., chapter in CRC book (2009), pp. 13-46</i>
10:30	Break
11:00	<b>Demo:</b> Creating FileX: Water and N Balance On <b>Reading/Reference</b> <i>DSSAT V3.5 Volume 2-1, pp. 1-93</i> <i>DSSAT V3.5 Volume 1-4, pp. 111-143</i> <i>DSSAT V4.0 Volume 2, XBuild User's Guide</i>
11:15	<b>Exercises:</b> Nitrogen Limited Crop Production <i>By J. Anothai, G.Mohan, A. Jintrawet</i> <b>Reading/Reference:</b> <i>Bowen et al. chapter in Kluwer book, pp. 189-204</i>
12:00	Lunch
13:00	<b>Exercises:</b> Continue with Nitrogen Limited Crop Production <i>By J. Anothai, A. Jintrawet, G. Mohan</i>
15:00	Break
15:30	<b>Lecture:</b> Modeling Soil Organic Matter <i>by G. Hoogenboom</i> <b>Reading/Reference:</b> <i>Gijsman et al., Agron Journal 94(2002):462-474</i> <i>Porter et al., Operational Res 10(2010):247-278</i> <i>Basso et al., Soil Sci Soc Am J 75(2010):69-78</i>
16:15	<b>Demo:</b> Creating fileX: Water and N Balance ON <i>by A. Jintrawet, G. Hoogenboom</i>
16:30	<b>Exercises:</b> Continue with Nitrogen Exercise <i>By J. Anothai, G.Mohan, A. Jintrawet</i>
17:30	Adjourn

### **Day5: Evaluation Risk and Sustainability**

<b>Time</b>	<b>Learning Activities</b>
08:00	<b>Exercises:</b> Continued <i>J. Anothai, G.Mohan, A. Jintrawet</i>
08:30	Feedback on exercises and software <i>by A. Jintrawet, J. Anothai, G. Mohan, G.Hoogenboom</i>
09:00	Lecture: Uncertainty, Risk, BMPs, and Sustainability <i>by G. Hoogenboom</i> Reading/Reference: <i>DSSAT V3.5 Volume 3-1, pp. 1-66</i> <i>Thornton and Hoogenboom, Agron. Journal 86(1994):860-868</i> <i>Thornton and Wilkens chapter in Kluwer book, pp. 329-345</i> <i>Bowen et al. chapter in Kluwer book, pp. 313-327</i> <i>Tojo Soler et al., Eur. J. Agronomy 27(2007):165-177</i> <i>Woli and Hoogenboom, Agric Water Management 201(2018):177-187</i>
10:00	Break
10:30	Demo: Creating FileX for Seasonal Analysis <i>by A. Jintrawet, G. Hoogenboom</i> Reading/Reference <i>DSSAT V3.5 Volume 2-1, pp. 1-93</i> <i>DSSAT V3.5 Volume 1-4, pp. 111-143</i>
11:00	Exercises: Seasonal Analysis <i>by J. Anothai, G.Mohan, A. Jintrawet</i>
12:00	Lunch
13:00	Exercises: Seasonal Analysis (Continued) <b><i>by J. Anothai, G.Mohan, A. Jintrawet</i></b>
15:00	Break
15:30	Lecture: Spatial Modeling Applications <i>by G. Hoogenboom</i> Reading/Reference <i>Hartkamp et al., Agronomy J 91(1999):22-28</i> <i>McNider et al., Env Modeling &amp; Software 72(2015):314-355</i> <i>Shelia et al., Env Modeling &amp; Software 115(2019):144-154</i>
16:00	Demo: Creating FileX for Spatial analysis <i>by A. Jintrawet, G. Hoogenboom</i>
16:45	Exercises: Continued 1. Seasonal Analysis 2. Spatial Analysis 3. Work with your Personal Experimental Data
17:30	Adjourn
18:30	Dinner (TBA)

### **Day-6: Model Applications and Next Steps**

<b>Time</b>	<b>Learning Activities</b>
08:00	<b>Exercises:</b> Continued <i>by J. Anothai, G.Mohan, A. Jintrawet</i>
08:30	Feedback on exercises and software <i>by A. Jintrawet, J. Anothai, G. Mohan, G. Hoogenboom</i>
09:00	Lecture: Cropping Systems – Simulating Crop Rotations <i>by G. Hoogenboom</i> Reading/Reference: <i>Thornton et al., Agron. Journal 87(1995):131-136</i> <i>Tojo Soler et al., J. of Agric. Sci 149(2011):579-593</i> <i>Liu et al., Agric Water Management 123(2013):32-44</i> <i>Adhikari et al., Trans ASABE 60(2017):2083-2096</i>
10:00	Break
10:30	Demo: Creating FileX for a Crop Rotation Simulation Reading/Reference DSSAT V3.5 Volume 2-1, pp. 1-93 DSSAT V3.5 Volume 1-4, pp. 111-143
11:00	Exercises: Creating a Crop Rotation or Sequence FileX Using XBuild Exercises: Simulating Crop Rotations in Long-term Experiments Exercises: Case Study – Chiang Mai, Thailand <i>J. Anothai, G.Mohan, A. Jintrawet</i> Reading/Reference DSSAT V3.5 Volume 3-2, pp. 67-127
	<b>Exercises:</b> Continued 1. Seasonal Analysis 2. Spatial Analysis 3. Crop Rotation Analysis 4. Case Study – Chiang Mai, Thailand 5. Work with your Personal Experimental Data <i>by J. Anothai, G.Mohan, A. Jintrawet</i>
12:00	Lunch
13:00	<b>Lecture:</b> Climate Change and Climate Variability <i>by G. Hoogenboom</i>
14:00	<b>Demo:</b> Creating FileX for Modeling Climate Change <i>By G. Hoogenboom</i>
14:15	<b>Demo:</b> Creating FileX for In-Season Yield Prediction <i>By G. Hoogenboom</i>
15:00	Break
15:30	Country's presentation and discussion on Applications and Needs, Online Survey for Participants, by All
16:45	Certificates, by All
17:30	Closing/Adjourn