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Climate Change, Agriculture and Food Security

Workshop report: A training program on the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT)

4-8 November 2019

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A training program on the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT)

Workshop Report

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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Abstract

The CCAFS project team at IFPRI in collaboration with the Indian Council of Agricultural Research (ICAR) team organized a 5-day capacity building workshop at the ICAR - National Institute of Agricultural Economics and Policy Research (NIAP). The workshop was conducted on IFPRI's IMPACT model and was attended by scientists and senior scientists working in various ICAR institutes, particularly in NIAP.

The training course introduced the IMPACT methodology, theory and scenario design to the participants. The course helped them gain an understanding on scenarios and scenario analysis. Participants learned how to use the network of models that make up IMPACT, how each module work and how they interact. They further learned to use IMPACT simulations, to design and run scenarios in IMPACT, and access and use IMPACT results correctly.

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Introduction

The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) was developed by the International Food Policy Research Institute (IFPRI) at the beginning of the 1990s to address the lack of long-term vision and consensus among policymakers and researchers about the actions necessary to feed the world in future, reduce hunger and malnutrition, and protect natural resource base. Over the years, the model has been updated and expanded, and presently IMPACT is now a system of linked models around core multimarket economic model for global production, trade, demand, and prices for agricultural products. The core model is linked to several modules that consist of climate model, water model, crop simulation model, value chain model, land use, nutrition and health, and welfare model. The core model focuses on national and global markets comprising of 159 countries, 62 agricultural commodities, 154 water basins, and 320 food production units. The IMPACT model integrates information flows from all the modules in a consistent equilibrium framework that support long term scenario analysis.

The IMPACT model is designed for scenario analysis rather than for forecasting purposes. It is a structural model that simulates the operation of commodity markets and behaviour of economic agents (e.g., producers and consumers) to determine demand and supply in the particular market. It is a partial equilibrium model in the sense that it is concerned only with agricultural commodities and thus covers only a part of economic activity of an economy. Keeping the structure of the IMPACT model in mind, it allows for integrated analysis of the implications of physical, bio-physical, and socio-economic trends and phenomenon allowing for in-depth study on a diversity of issues policymakers are interested in. The model has already been used to investigate research linkages between agricultural production and food security at the national and regional levels. It has also led to commodity wide analyses and contributed to thematic and interdisciplinary scenario-based projects. There are various linkages that are yet to be explored.

The CCAFS project team at IFPRI, in collaboration with the Indian Council of Agricultural Research (ICAR) team, organized a 5-day capacity building workshop at the ICAR - National Institute of Agricultural Economics and Policy Research (NIAP). The workshop was

conducted on IFPRI's IMPACT model and involved scientists and senior scientists working in various ICAR institutes, particularly in NIAP.

About the training program

Course pre-requisites

- Basic understanding of economics
- Familiar with at least one report based on the IMPACT model: http://www.ifpri.org/book-751/ourwork/program/impact-model
- Software requirements for the training
- Have GAMS installed

Training objectives

- Learn about IMPACT methodology, theory, and scenario design
- Gain an understanding on scenarios and scenario analysis
- Understand the network of models that make up IMPACT
- Understand in general terms how each of these modules work and interact
- Learn how to use IMPACT simulations in Excel User Interface
- Learn to design and run scenarios in IMPACT
- Learn how to access and use IMPACT results correctly

Schedule of activities

Day 1 (4 November 2019)

Morning 1

- Introduction, administrative and technical issues
- Introductions and workshop logistics
- Presentation of workshop objectives
- Getting software correctly installed and configured

Morning 2

- Introduction to scenarios and scenario analysis

- Defining scenarios, how and why they are useful
- Presentation of some history on the use of scenarios
- Explanation of the difference between forecasting and scenario analysis

Afternoon 1

- Introduction to the IMPACT modeling world
- Introduction of the different component to the IMPACT suite of models
- Presentation of IMPACT data inputs and presentation of improvement exercises for IPR/RAP update and SPAM data
- Presentation of FAOSTAT, Aqua Stat, AMAD, SPAM, etc.
- Modelling of biophysical effects

Afternoon 2

- Presentation of climate models, water models and crop models
- Introduction of the climate science from the IPCC AR5, which serves as the foundation of IMPACT scenarios
- Presentation of the 3 IMPACT water models individually
- Explanation of how the 3 water models are linked to each other
- Explanation of how the water models are linked to the trade model
- Presentation on DSSAT and crop modelled biophysical shocks

Day 2 (5 November 2019)

Morning 1

- Introduction of the Trade Model
- Presentation of IMPACT Economic Theory 101
- Explanation of area demand and land markets
- Explanation of activity-commodity break down
- Explanation of prices and their role in IMPACT

Morning 2

- Explanation of post-solution modules
- Describing the malnutrition and food security modules
- Explanation of the surplus analysis and welfare-benefit-cost module in IMPACT

Afternoon 1

- Using IMPACT

Afternoon 2

- Introduction to IMPACT UI
- Setting up IMPACT 3 on all participants computers, and become familiar with the Excel Interface
- Setting up basic scenarios
- Walking through accessing model results in GAMS

Day 3 (6 November 2019)

Morning 1

- Using IMPACT continued

Morning 2

- Basic scenario design and analysis
- Running a simple climate scenario
- Presentation of initial results and analysis and getting feedback on interpretation of results

Afternoon 1

- IMPACT scenario development continued
- Developing more complex scenarios

Afternoon 2

- Start designing and running scenarios using user created drivers (yields, land, etc.)
- Analysis and report on the results of these scenarios

Day 4 (7 November 2019)

Morning 1

- IMPACT scenario development continued
- Technology adoption and welfare analysis
- Development of a technology adoption scenario with costs

Morning 2

- Learning to run the welfare benefit cost module and how to interpret the results
- Presentation of analysis from the technology scenario
- Tools and methodological strengthening

Afternoon 1

- Revisiting IMPACT methodology and theory
- Providing time for questions and further review of IMPACT methodology and theory

Afternoon 2

- Creating multiple scenarios and analyzing effects
- Development of a series of scenarios
- Running these scenarios overnight to allow for analysis the next day

Day 5 (8 November 2019)

Morning 1

- Tools and methodological strengthening
- Scenario analysis

- Analysis of scenarios developed in the last session and analysis of the effects of each scenario, and the effects of stacking the scenarios in combined complex scenarios

Morning 2

- Feedback and next steps
- Discussion of next steps and what needs to be done
- Feedback from participants on the workshop

List of participants and organizers

Training coordinators:

- Dr. Anjani Kumar, IFPRI-SAR (anjani.kumar@cgiar.org)
- Dr. Prem Chand, Scientist, ICAR-NIAP (prem.chand@icar.gov.in)

Resource persons:

- Dr. Nicostrato Perez, IFPRI (n.perez@cgiar.org)
- Dr. Barun Deb Pal, IFPRI-SAR (b.debpal@cgiar.org)

Technical assistance:

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- Ms. Shreya Kapoor, IFPRI-SAR (s.kapoor@cgiar.org)

Participants:

- Dr. S.K. Srivastava, Scientist, ICAR-NIAP (sk.srivastava@icar.gov.in)
- Dr. Abhimanyu Jhajhria, Scientist, ICAR-NIAP (Abhimanyu.jhajhria@icar.gov.in)
- Dr. Anuja A.R., Scientist, ICAR-IASRI (anuja.ar@icar.gov.in)
- Dr. P. Venkatesh, Senior Scientist, ICAR-IARI (venkatesh1998@gmail.com)
- Dr. Kiran Kumar, Scientist, ICAR-CSSRI (kiran.tm@icar.gov.in)
- Mrs. Nithyashree M.L., Scientist, ICAR-IARI (Nithya.econ@gmail.com)
- Dr. Surabhi Mittal, Agricultural Economics Research Association (surabhimittal@gmail.com)
- Dr. Balaji S.J., Scientist, ICAR-NIAP (balajiniap@gmail.com)

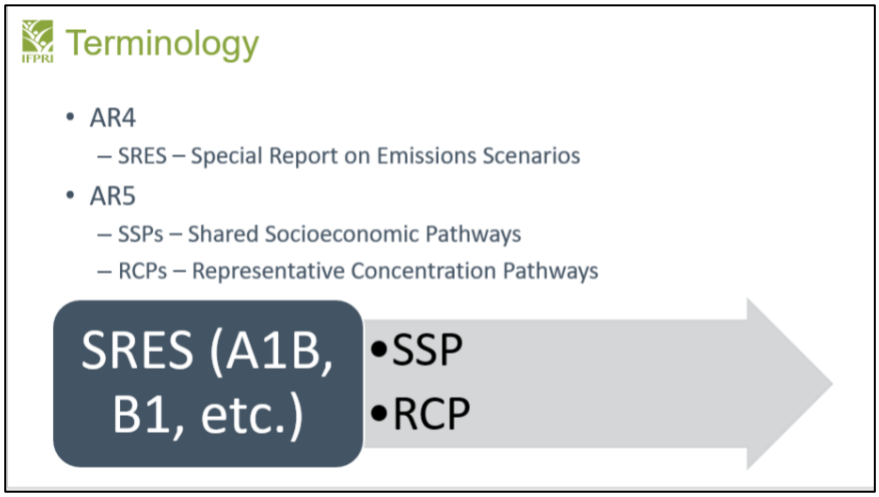
- Dr. Balasubramanian, Scientist, ICAR-IARI (bala.sbrmnn@gmail.com)
- Dr. Kingsly Immanuelraj, Scientist, ICAR-NIAP (k.immanuelraj@icar.gov.in)

Day 1

The session was inaugurated by the Director of ICAR-NIAP, Dr. Suresh Pal. He extended his heartiest and warm welcome to Dr. Nicostrato Perez, participants, and the team from IFPRI. He gave a brief introduction to the IMPACT model and highlighted the importance of its application in deriving various linkages through the interactions occurring between agricultural sector and economic agents. He spoke about his interest in designing new economic policies from the model and encouraged the young scientists to learn the same by stressing on its applicability and versatility. Following, Dr. Anjani Kumar, Research fellow from IFPRI addressed the audience by welcoming them to the training workshop. He spoke on the utility of the model in farming policies for future economic growth and sustainability. Dr. Pal and Dr. Kumar laid emphasis on the 'impact evaluation' feature of the model under the dynamic climatic change scenarios and scheming programs and policies that counters the adverse impact of the climate change.

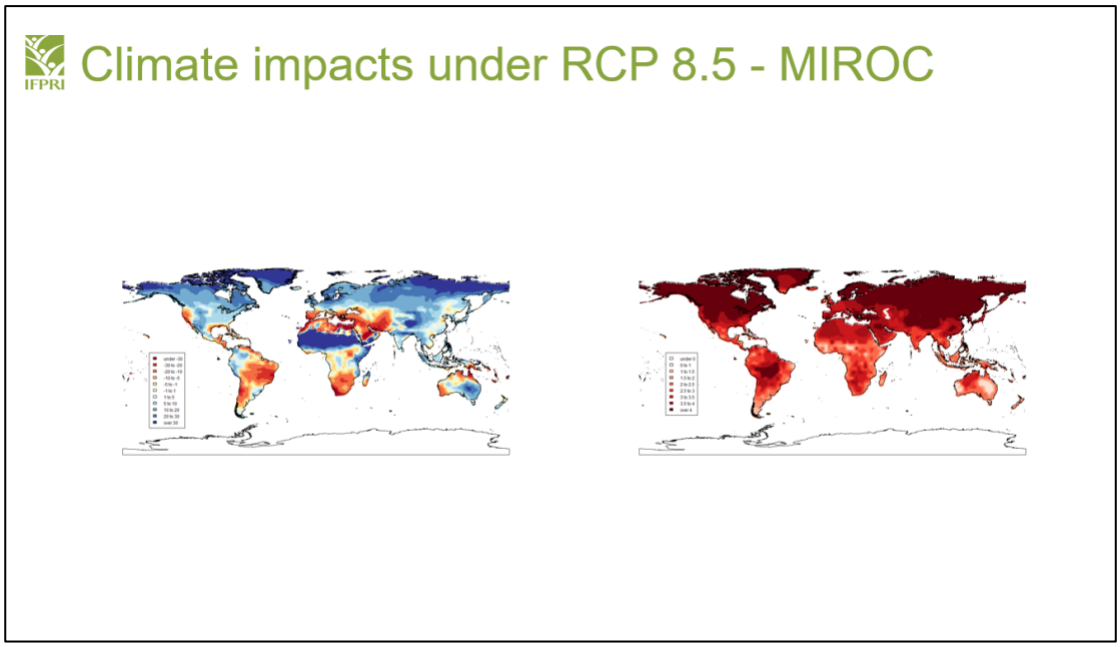
The session started with enthusiasm and eagerness to learn from the group of researchers. Dr. Perez started the training session by introducing the IMPACT model to the audience. He explained the history behind the formation of IMPACT model and his contribution in its framework. He also discussed the working mechanism of the model. Further, he elaborated on the basics of economic analysis i.e., demand and supply equilibrium. He explained various terminologies used in the IMPACT model such as RCP, SSP, AR4, AR5 etc.

Figure 1. Terminologies explained by Dr. Perez



Dr. Perez also gave visual illustrations of global climate impacts under different climate change scenarios as put forth by the IPCC. He talked about five different default scenarios mentioned in the IMPACT model, namely, NoCC, GFDL, HadGem, IPSL, and MIROC. He illustrated the differences in impact of climate change on precipitation and temperature globally under the above-mentioned scenarios. Further, he spoke about the annual growth rates region-wide from 2010 to 2050 in terms of GDP, population, and per capita GDP.

Figure 2. Impact of climate change on precipitation and temperature globally



Following this, Dr. Perez also talked about the partial equilibrium models and the type of estimation required for such models. Secondly, he pointed out the different data sources used

in the IMPACT model. He mentioned that FAOSTAT had been used for collecting production, demand, trade, and nutrition data for various countries, and AQUASTAT was used for data collection on country's irrigation and rainfed production. This much information passed to the participants led to a discussion amongst the group. Dr. S.K. Srivastava along with some colleagues questioned the forecasted data and its relevance but was later convinced after an explanation provided by IFPRI team. Towards the end of the session, Dr. Perez explained the mechanism of the IMPACT model along with illustrating the integration of several endogenous and dynamic models within it. He talked about the two major aspects of IMPACT model, i.e., food and water model. Lastly, he talked about the mapping of DSSAT data into the IMPACT model. All this led to a discussion between the group of scientists and the instructor. The major question that was lingering in the minds of the scientists was the mathematical formulation of the model and the derivation of the model results.

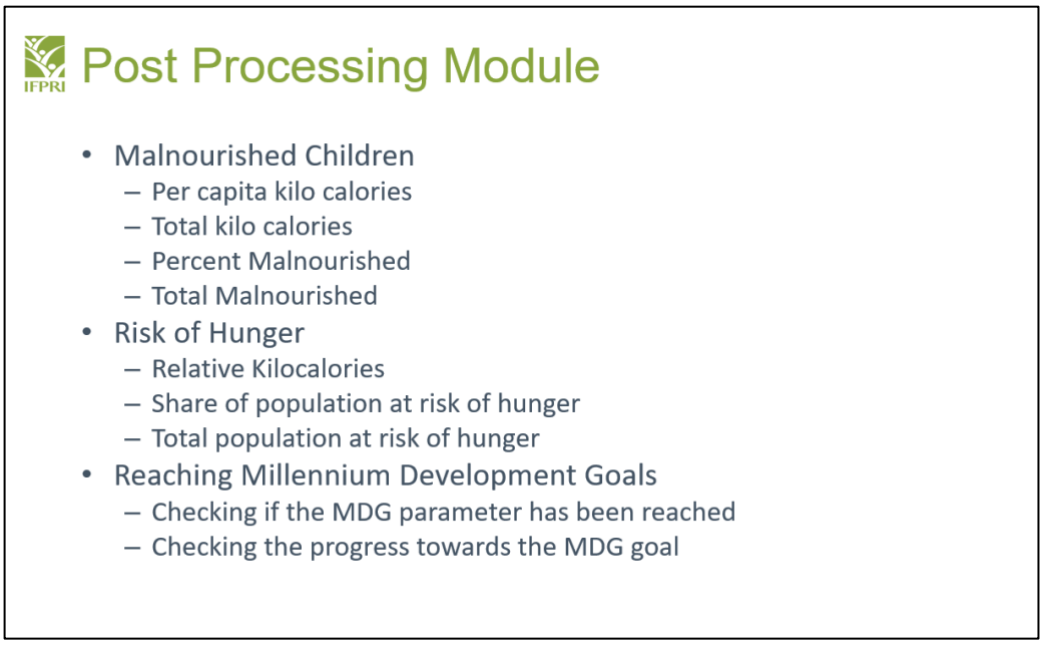
Discussion among the participants and Dr. Perez

Day 2

Dr. Perez started the session by giving a detailed explanation about the IMPACT model and its working framework. He described the various integration of models embedded inside the IMPACT model. He further explained the role of prices and its impact on the model along with the demand and supply analysis. The entire explanation of the mechanism of the model

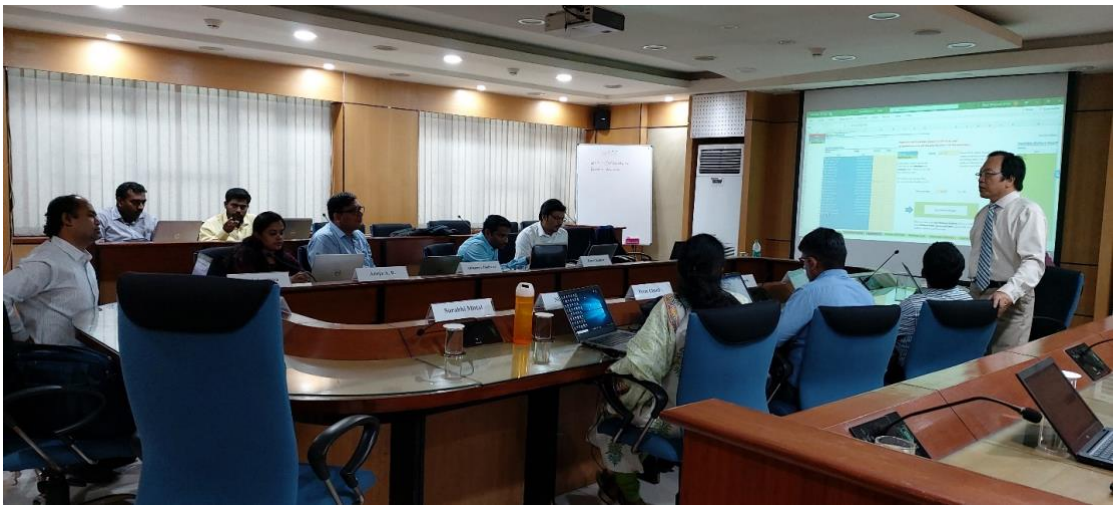
led to different doubts in the minds of the scientists. One of the scientists, Dr. Balaji wanted a clarification on how the model can be used for analyzing impact within a domestic country since the data available in the model is on global level. Similar type of question was raised by Dr. Srivastava, where he mentioned the relevance of tariff rates present in the model. He pointed out that the tariff rates mentioned in the model are based on 2005 baseline data but in a dynamic world, he asked how this can hold true. Another scientist, Dr. Surabhi Mittal argued about the degree to which these predictions hold true when compared with current scenario. She pointed out that the population growth rates mentioned for India were not correct in the simulated datasheet present in the model. Dr. Perez replied to all the questions raised by the scientists and told them there is a way to model the program to be able to get answers to such questions. Further, he discussed the post estimation modules i.e., welfare models and malnutrition models.

Figure 3. Post processing module discussed by Dr. Perez



After lunch, the session started with full enthusiasm among the participants and Dr. Perez. The session started with working of the GAMS software and the Excel User Interface of the IMPACT model. The software and the model rose interest among the scientists, and this led to more discussions and debates among the panel members. Later, Dr. Perez discussed scenario formation with the scientists. He taught them how to frame policies under different conditions and how to counter the adverse effects of climate change. The second half of the

day was followed by discussions on framing different scenarios under climate change and designing policies to combat the ill impact of climate change on the economic parameters.



Group discussion

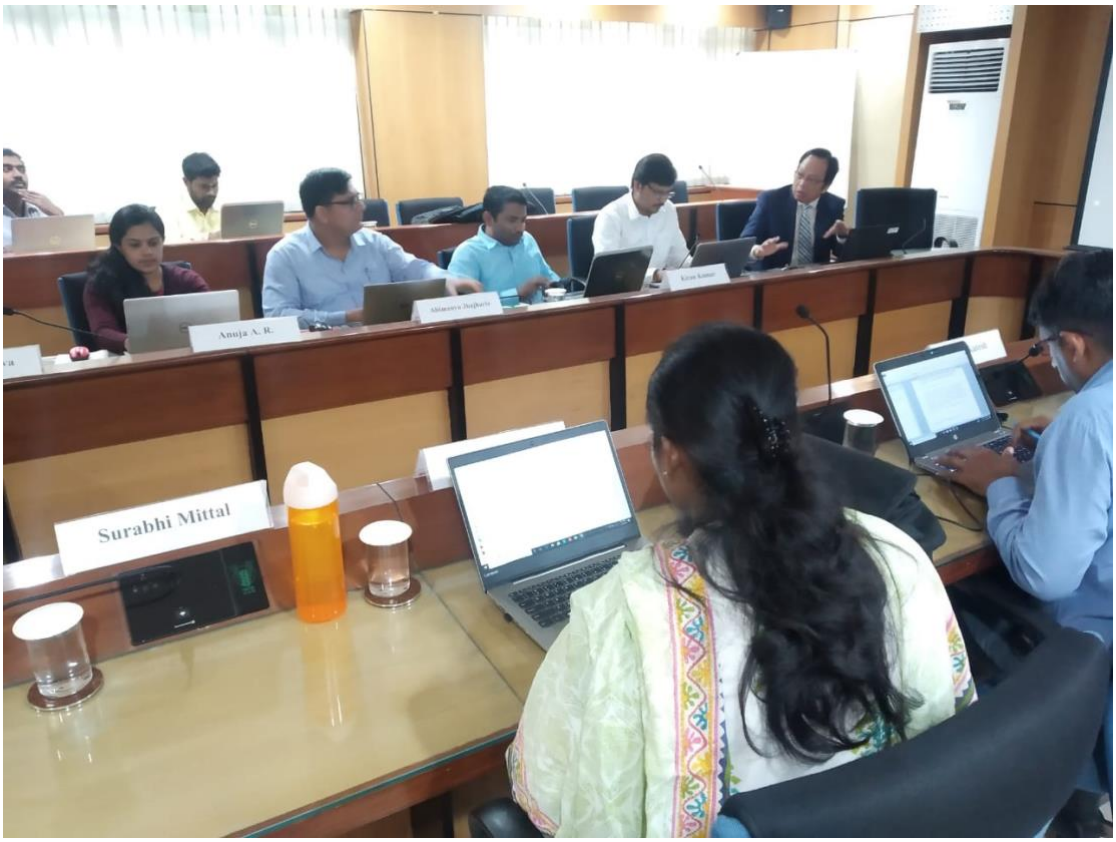
Day 3

Day 3 started with the explanation to the IMPACT model presented by Dr. Perez. He explained the various concepts again to the audience for further clarifications. He emphasized the development of different types of scenarios under climate change situations. He framed some situations for the participants to give them an idea on framing scenarios such as designing policies to double the yield of some crops (wheat, rice, maize, potato, etc). He provided some scenarios to the scientists to brainstorm over and come up with various policy solutions to it. Dr. Kiran Kumar pointed out an issue regarding the salinity of the soil in Haryana and motivated his fellow participants to brainstorm over this topic. Later, Dr. Srivastava insisted on debating over the aspect of trade tariffs measured using the IMPACT model. In addition to this, Dr. Perez also provided a few suggestions in finding the impact of climate change on agriculture, for example changing the growth rates of animal yield and manipulating the growth rates of land area under rain-fed and land under irrigation. In the second half of the session, he divided the participants into three groups and assigned them complex climate change scenarios to solve and to present a report with the results.

The teams and scenarios were as divided as follows:

- **Team 1:** Dr. Abhimanyu Jhajhria, Dr. Kiran Kumar, Dr. Balaji S.J.
- **Scenario 1:** Impact of climate change on global agriculture, nutrition and hunger
- **Team 2:** Dr. M. Balasubramanian, Dr. S.K. Srivastava, Dr. Anuja A.R., Dr. P. Venkatesh
- **Scenario 2:** Impact of climate change in SAARC countries (Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka)
- **Team 3:** Dr. Kingslay, Dr. Nithyashree, Dr. Prem Chand, Dr. Surabhi Mittal
- **Scenario 3:** Impact of heat and drought tolerant varieties of wheat in West Asia and South Asia, respectively

The teams started discussing among themselves about their given scenarios. Teams brought forth different ideas to tackle the situation of climate change. They tried to find out the impact of climate change on agriculture with respect to parameters such as land area, yield growth rates, livestock productivity, population growth rates, malnutrition, calorie consumption, etc.

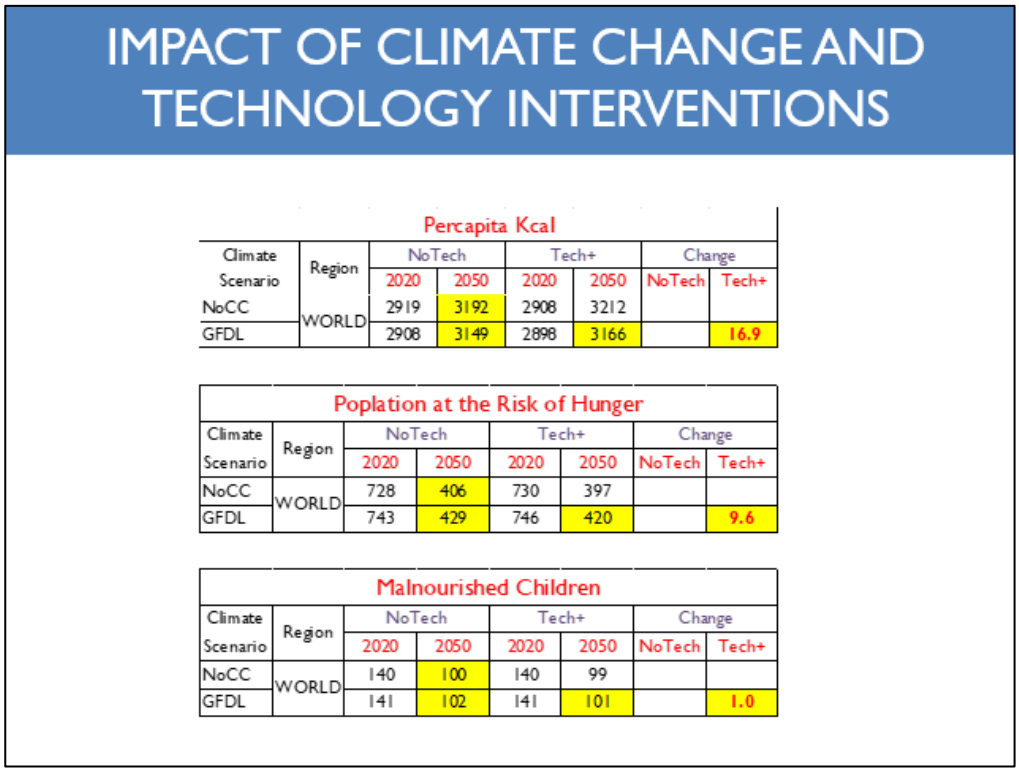


Group discussion among the participants and Dr Nicostrato Perez

Day 4

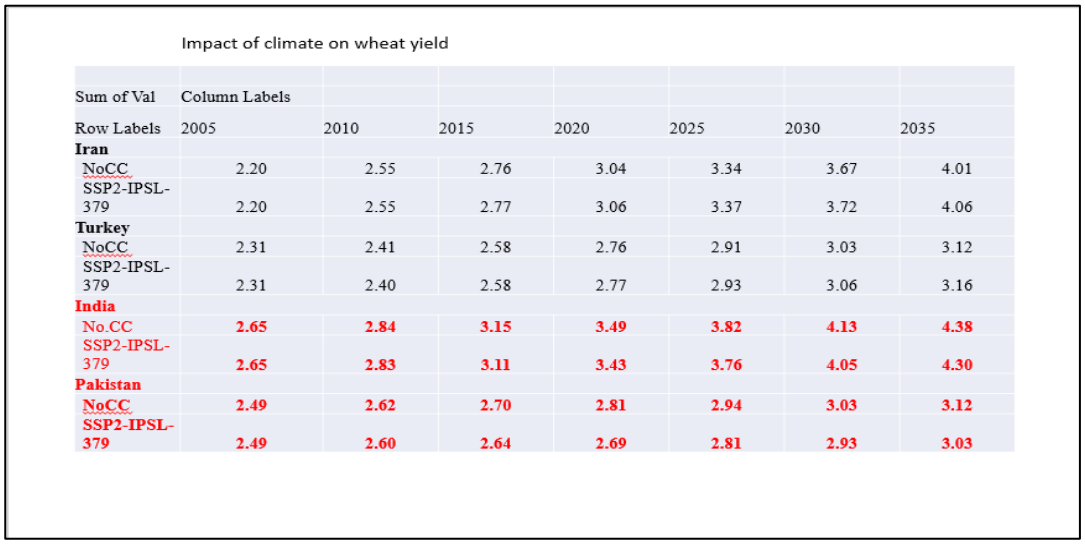
The day started with exciting presentations from the three teams on their respective scenarios. This was followed by an intensive discussion over the results generated by the three teams on their respective scenarios. The first presentation was done by team 1 on the impact of climate change on global agriculture, nutrition and health. They had two main questions which included the effects of climate change across the world and how technology interventions in agriculture can help in tackling the effects of climate change. The team considered four main agricultural products (rice, wheat, potato and beef) and the parameters that they included were yield for crops (potato, rice and wheat), animal yield (beef) and technological yield. The concept that they mentioned for choosing these products was that not all countries have the same technical growth rate and secondly, countries adopt the principle of comparative cost advantage. Team 1 chose main exporting countries for the selected commodities to facilitate the impact of climate change. The results pointed out that the per capita calorie consumption under climate change was reducing when compared with no climate change scenario. On the other hand, the number of malnourished children and population at the risk of hunger was reducing horizontally when compared across years under a given climate scenario.

Figure 4. Team 1 presenting results



After this, team 2 continued with their presentation. They had to create a scenario in which there was a comparison between drought- and heat-tolerant varieties of wheat. Drought-tolerant variety was introduced in Turkey and Iran while heat-tolerant variety was introduced in India and Pakistan. For the drought-tolerant variety in Turkey and Iran, the team found a positive result in the increase of wheat yield over the years in no climate change as well as in climate change scenario. But, for India and Pakistan, the results turned out to be negative. The productivity of wheat was reducing over the years in both no climate change and in climate change scenarios. They checked for the effect of improved variety of seeds on malnutrition in South Asia. They found out that malnutrition was decreasing in the new scenario when compared with the baseline results. On the contrary, regional trade showed an opposite result with a negative impact of improved technology in South Asia.

Figure 5. Team 2 presenting results



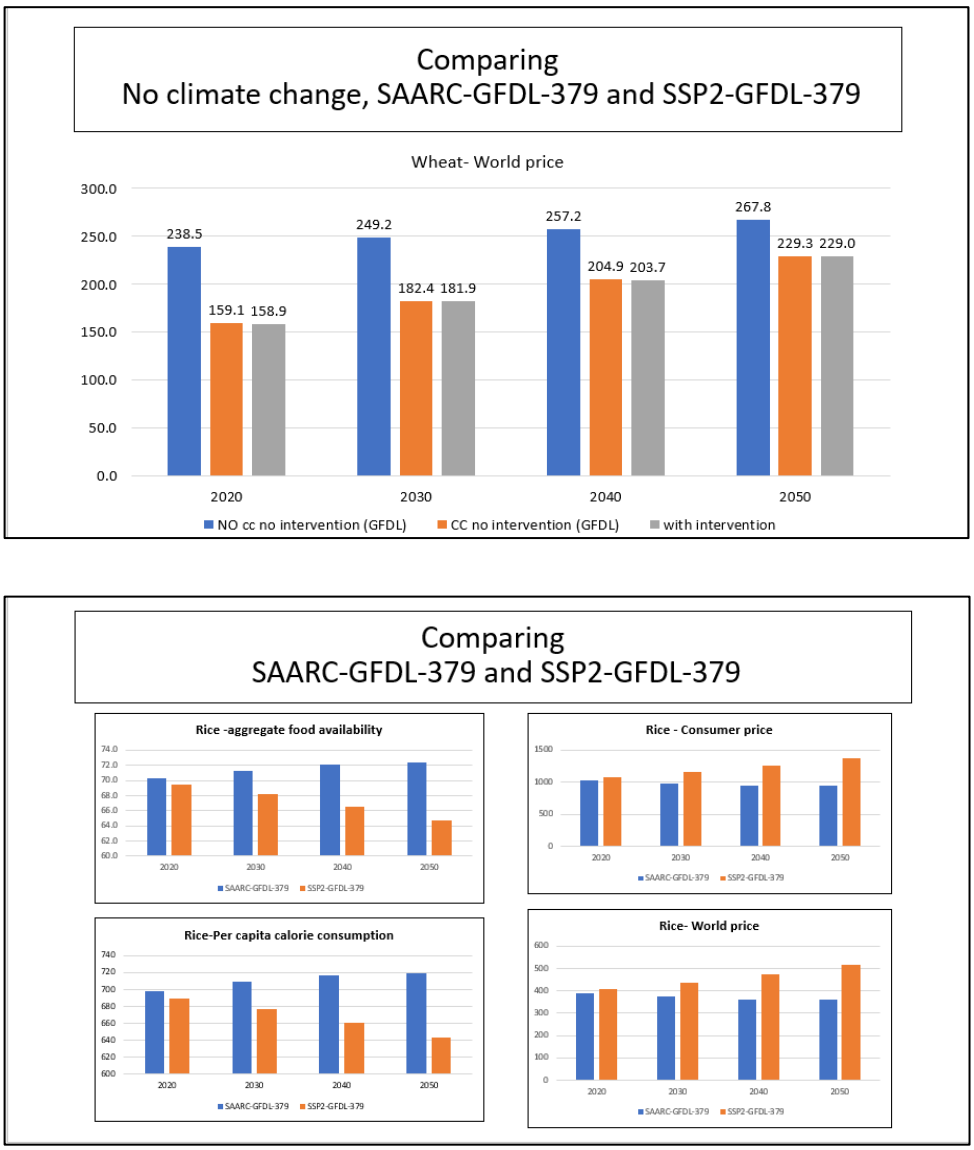
Impact of climate on wheat yield

Sum of Val	Column Labels						
Row Labels	2005	2010	2015	2020	2025	2030	2035
Iran							
NoCC	2.20	2.55	2.76	3.04	3.34	3.67	4.01
SSP2-IPSL-379	2.20	2.55	2.77	3.06	3.37	3.72	4.06
Turkey							
NoCC	2.31	2.41	2.58	2.76	2.91	3.03	3.12
SSP2-IPSL-379	2.31	2.40	2.58	2.77	2.93	3.06	3.16
India							
No.CC	**2.65**	**2.84**	**3.15**	**3.49**	**3.82**	**4.13**	**4.38**
SSP2-IPSL-379	**2.65**	**2.83**	**3.11**	**3.43**	**3.76**	**4.05**	**4.30**
Pakistan							
NoCC	**2.49**	**2.62**	**2.70**	**2.81**	**2.94**	**3.03**	**3.12**
SSP2-IPSL-379	**2.49**	**2.60**	**2.64**	**2.69**	**2.81**	**2.93**	**3.03**

Team 3 had an analysis based on the SAARC region which included Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. They emphasized parameters like population growth rate, GDP growth rate, yield growth rate, irrigated land area, technological yield and introduced a new variety of crop seed. They assumed a logistic adoption function with maximum rate of adoption to be 60%. Team 3 found that the number of malnourished people was reducing when interventions were put under the climate change scenario. Secondly, they also found that initially the world price of rice was increasing under the GFDL scenario but with the introduction of the interventions, the world prices of rice decreased drastically. The results also pointed out the increase in food availability, per capita calorie

consumption, and a decrease in consumer price of rice globally. Similar sets of results were found in the case of wheat crop allowing for the above-mentioned interventions in the parameters.

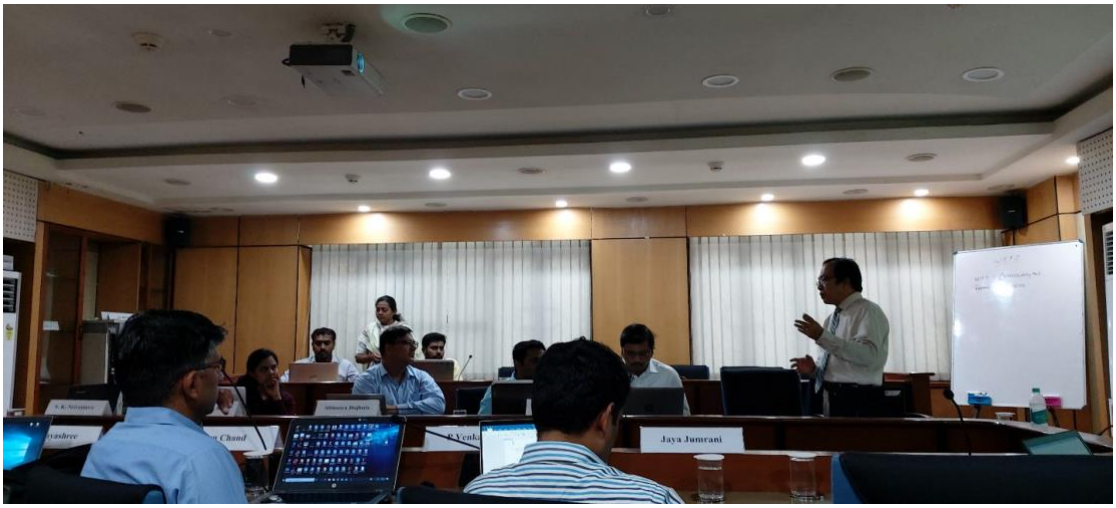
Figure 6. Team 3 presenting the results of their analysis



Later, Dr. Perez taught participants the post modular estimation of the welfare model in which he discussed the producer and consumer surplus. In addition to this, he also talked about the net welfare impact on the economy under different baseline climate change scenarios present in the model.

Day 5

The day started with a brainstorming session on creating scenarios for how to use the IMPACT model in doing sub-national analysis of India. Discussions were made regarding the rice belt in Punjab and Haryana keeping in mind the sustainability aspect of the environment. Dr. Srivastava laid emphasis on the decentralized procurement of wheat and paddy which can be more fruitful in increasing the terms of trade for India.



Dr Nicostrato Perez discussing with the scientists

Dr. Barun Deb Pal from IFPRI talked about the International Pulses Year celebrated in India when there was excess production of pulses in India. Later he talked about how world prices for pulses fluctuated when India stopped importing them from Canada and Myanmar. Dr. Anuja from IASRI discussed establishing inter-state trade linkages in India to smoothen the flow of goods and services within the country. Further, there was a discussion on the CGE model and the ADOPT model. Dr. Barun Deb Pal explained the integrities of the CGE model and how it is used in simulating the IMPACT model. Dr. Perez highlighted a few points in determining inter-state trade linkages such as examining regional state markets, market fragmentation, transportation cost, infrastructure, processing and storage costs, and trade flows. Following the discussion, participants could discuss their problems with Dr. Perez. They addressed their doubts in running the IMPACT model as well as the GAMS software. Here, the instructor tried to give one-on-one attention to the participants in solving their queries.

After the doubt-solving session, the day continued with closing ceremony and lunch. The closing ceremony was marked by a vote of thanks from Dr. Suresh Pal, Director of ICAR-NIAP. He expressed his gratitude to Dr. Perez for coming all the way from the USA to deliver such a wonderful training program. Dr. Suresh Pal also thanked the IFPRI team present throughout the five-day training program for providing help and assistance to the participants. He also congratulated the participants on successfully completing the training program.

Following the vote of thanks, Dr. Balaji gave a comprehensive presentation covering aspects from all the three group assignments done by the scientists the day before. Dr. Balaji expressed how certain interventions made in some countries and few crops can help in maintaining stability worldwide in agriculture and food security along with maintaining development goals and economic growth. Finally, the training program came to end by receiving feedback from the participants and certificate distribution. Later, Dr. Perez shared his experience of the training modules.

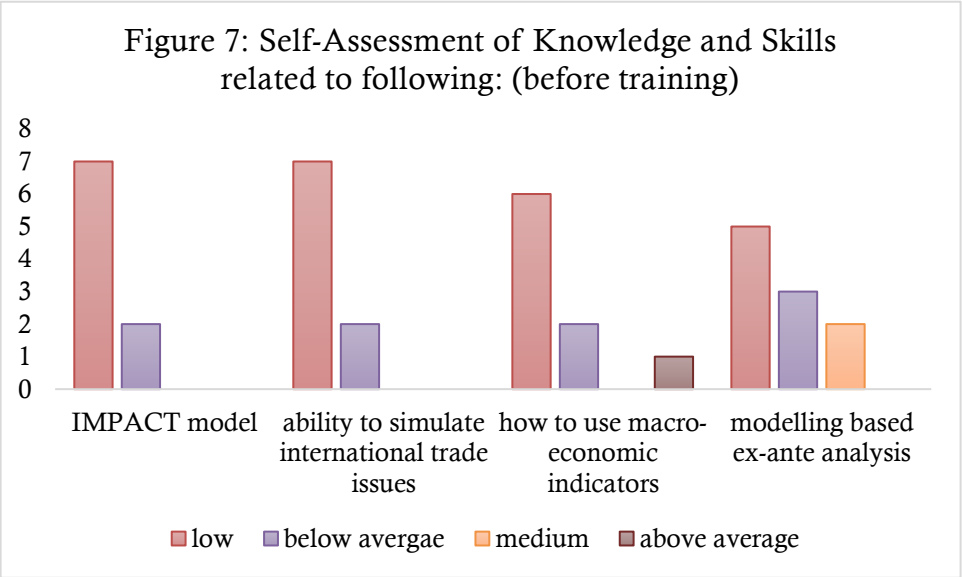
Dr. Balaji giving a comprehensive presentation from the team assignments

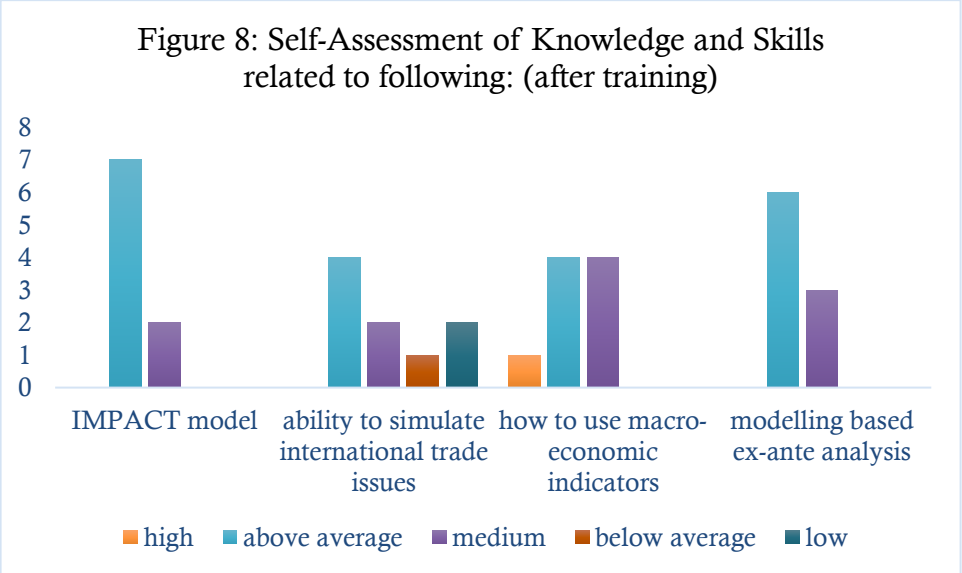
Each of the participants expressed their gratitude to NIAP, IFPRI and Dr. Perez for making them learn something new and productive. They felt that the IMPACT model was really very helpful in analyzing how small changes made in certain parameters can benefit or harm agriculture and food security.

Dr Prem Chand expressing his thoughts on training program

Certificate distribution after successful completion of the training

Figure 7 and 8. Self-assessment of knowledge and skills. Feedback from the participants.





From the above two graphs, we can see that prior to the training, participants had very sparse knowledge about the IMPACT model, how to use macro-economic indicators, how to simulate data to tackle international trade issues and modelling based on ex-ante analysis. From figure 8, it is evident that the training has been useful to the participants in building their ability to simulate data and use macro-economic indicators to model using ex-ante analysis.

When asked about the new and important things learned, participants mentioned exposure to the IMPACT model along with the mechanism through which it runs, as well as the Excel User Interface that connects IMPACT model with the GAMS software. The participants stressed that the exposure to designing scenarios and policies under different circumstances was new and very interesting to them. The participants were satisfied with the delivery of lectures and the reading materials provided to them.

Figure 9. Rating of training on various parameters

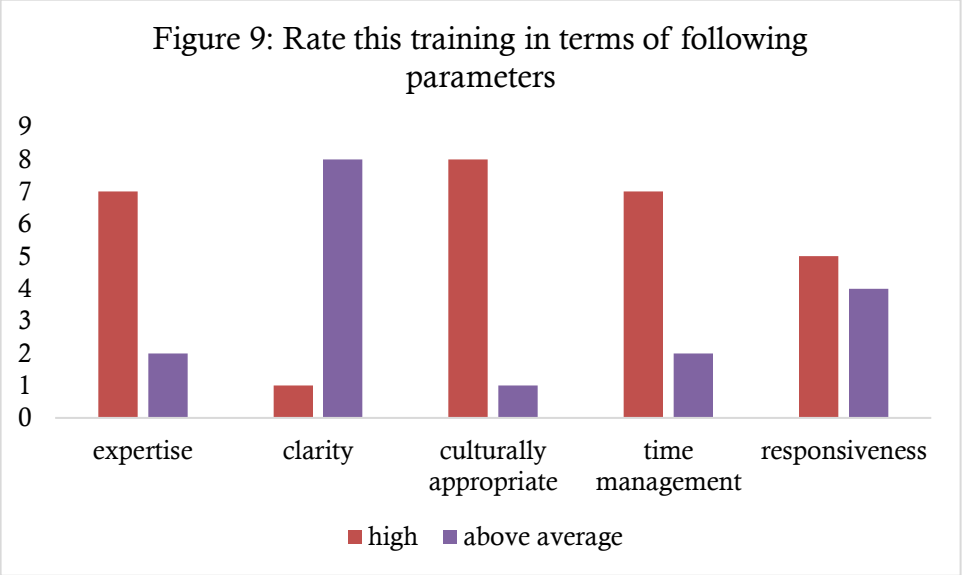


Figure 9 shows that the training has been able to meet the participants' expectation in terms of expertise, clarity, culturally appropriateness, time management, and responsiveness. Participants have rated all above elements either high or above average.

Figure 10. Rating of how training will make a difference in participants' work

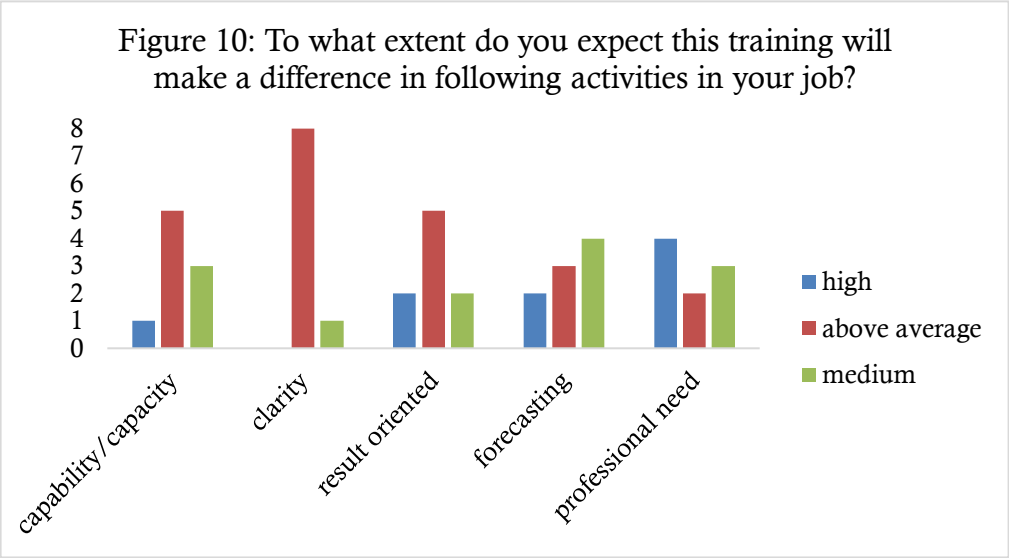


Figure 10 shows that the scientists have found the IMPACT model training to be beneficial for them in terms of their career opportunities.

The participants showed interest in using the IMPACT model for their research work. They expressed working with issues such as: (i) increasing water stress, (ii) negative environmental externalities, (iii) cropping pattern, (iv) change in trade structure due to changes in crop yield, (v) impact of climate change on India's food security and malnutrition status, (vi) impact of technological interventions on market equilibrium and welfare, and (vii) impact of reclamation technologies on salt-affected soils at the national level on employment, poverty and other socio-economic indicators.

Conclusion

The overall experience shared by the participants was very satisfactory. They found the group assignment exercise to be very fruitful in capacity building. It also helped in broadening their horizon to think about different interventions as well as framing policies to counteract the adverse effects of climate change.

Group photo