Yield Gap Analysis for Potato & Sweetpotato Under Changing Climate in Asia

Highlights of Regional Workshop

GENERAL OVERVIEW

Background

Asia is the world's leading producer and consumer of root and tuber crops (RTCs) – especially for potato and sweetpotato. Known for their versatile uses and markets, RTCs serve as multi-functional crops for food, feed, processed and other industrial products. They are adapted to a wide range of production ecologies and are associated with both intensive commercial systems.

RTCs are well recognized for their role in the food security and livelihood of Asia's rural poor as staple/supplementary food and cash income with relatively minimal input. They also help point the critical link between poverty and climate change. Poorer, smaller-scale RTC producers generally grow the crops in more resource-limited environments, and often under increased abiotic and biotic stresses.

Among the key resilience and sustainability challenges for RTCs in the region include: 1) degrading natural resources in upland, rainfed and coastal production zones; 2) increasing vulnerability to natural disasters and socio-economic crises; and 3) changing farming goals and practices as driven by dynamic markets. On the other hand RTCs are traditionally seen as having greater adaptability to changing climate (e.g. drought and heat); they thrive even in less favorable production areas and seasons where cultivation of other crops may no longer be agro-economically feasible.

Workshop Rationale and Objectives

Since 2012, Food Security Through Asian Roots and Tubers (FoodSTART) Project has facilitated collaborative research for in-country GIS mapping to promote and guide large-scale development investments in RTCs for food security.

Building on its initial mapping outputs, FoodSTART seeks to incorporate a climate-change perspective in prioritizing geographic targets for research and development interventions. The International Potato Center (CIP) and national partners seek to undertake yield gap analysis , through crop growth modelling tools, for long-term scenarios on the climate-change impact on RTCs yield and performance. Yield gap analysis is a relatively simple, widely used methodology for assessing and projecting crop/varietal yields over time, as influenced by biophysical changes in the production system and environment, e.g. water availability, temperature.

The regional workshop aimed:

- ⇒ to enhance national capacities particularly in Southeast Asia, for yield-gap analysis in assessing climate change impact on RTCs production;
- ⇒ to synthesize baseline information on crop and varietal performance for key RTCs-growing communities in the region;
- ⇒ to formulate long-term scenarios of RTCs as decision-support tool in investment planning for RTCs research and development.

The workshop was held on 24-28 February 2014 in Manila, Philippines. The workshop was organized in partnership with two CGIAR Research Programs – Climate Change for Agriculture and Food Security (CCAFS) and Roots, Tubers and Bananas (RTB).

Workshop outputs serve as input to CCAFS and RTB agenda/priority-setting by helping: a) build regional knowledge base on climate change in the root and tuber crops sector, and b) identify needs and opportunities for action-oriented research in the target countries.

WORKSHOP PROCESS and METHODOLOGY

Workshop Design

The workshop served as a regional knowledge-sharing and learning platform through which: a) national research organizations jointly undertake modelling and scenario analysis using harmonized research frameworks and methodologies; b) Asia's intra-regional pool of expertise and methods is mobilized, with backstopping from CIP, and c) representatives of research, development and policy-making organizations collectively develop and use long-term scenario information to guide in-country investment planning.

The five-day activity consisted of the following key sessions: a) introduction to frameworks, methods and tools in yield gap analysis, b) review of baseline information per country/crop and results of any prior yield gap analysis , c) exercises in database development, modelling and scenario analyses, d) stakeholders consultation and validation.

Yield gap analysis was conducted for two target RTCs – potato and sweetpotato – in six Asian countries. Except for Lao PDR, both crops were covered in each country. Yield gap analysis was undertaken using two crop growth simulation models: 1) SOLANUM for potato, developed by CIP's Integrated Crops and Systems Research Program, and 2) SPOTCOMs for sweetpotato, developed by India's Central Tuber Crops Research Institute (CTCRI).

Country	Potato	Sweetpotato
China	♦	♦
India	♦	♦
Indonesia	♦	♦
Lao PDR	♦	
Philippines	♦	♦
Vietnam	♦	♦

As pre-workshop assignment, participants compiled existing data on varieties, agronomic performance and climate parameters using templates provided by resource persons/facilitators.

SWEETPOTATO YIELD GAP ANALYSIS

The workshop resulted in five key types of yield-gap analysis outputs for sweetpotato.

1. *Yield gap comparison between varieties as affected by crop fertilization* -- e.g. in India, three varieties showed significant difference in potential yield for 2020 and 2030 scenarios under normal fertilizer application. Variety Kishan has the highest potential yield reduction of up to 14.3% when grown in Odisha state. Similar yield reductions are projected for varieties Sourin and Kalinga.
2. *Yield gap comparison between locations for the same variety* – e.g. in Indonesia, Both actual and potential yields differed for variety Sukuh under growing conditions in Wamena uplands (1660m asl Papua province) and Bogor lowlands (200m asl West Java province). Potential yield is 10.03 t/m for the former while 29.15 t/m for the latter.
3. *Yield gap comparison between farmers' actual yield and estimated potential yield.* In China, potential yield for variety Nanshu 88 in Sichuan province is the highest among all varieties and locations covered in the analysis during the workshop. Even with a projected decrease in potential yield by 2030, Nanshu 88 remains the highest potential yielder at 66.6 t/ha, when planted in Sichuan.
4. *Yield gap comparison as affected by extreme weather events* – e.g. in the Philippines, historical data under Leyte province conditions showed that potential and actual yields of variety SP30 was unaffected by La Nina weather phenomenon (2006). However, actual yield was significantly reduced (from 9.73 to 4.37 t/ha) under El Nino conditions in 1998.
5. *Yield gap scenarios as affected by climate change* – e.g. in Vietnam, potential yield of variety Hoang Long is unaffected by climate change for 2020 and 2030, under growing conditions in Hoang Long and Bac Giang provinces. On the other hand, CIP clone 97.1.1 is projected to have reduced potential yield due to climate change in 2030 (from 39.9 to 35.9 t/ha in Hai Doung, and from 48.4 to 43.2 in Bac Giang.

Meanwhile for potato, the workshop resulted in four key types of yield-gap analysis outputs:

1. *Yield gap comparison between actual farmers' yield and potential yields* -- e.g. across six sites in Asia, potential yields are higher by up to four times than farmers' actual yields. For example, yield levels in Lao PDR are 40 t/ha for the former while 8 t/ha for the latter. In Inner Mongolia province which has the lowest actual yield (15 t/ha) among the three sites in China, potential yield is 48 t/ha.
2. *Yield gap comparison as influenced by planting date* -- e.g. in Guangxi (China), current planting date is optimal while crop yield significantly increases when planting is delatey one month in Meghalaya (India) and advanced two months in Yunnan (China).
3. *Yield gap comparison based in stability of potential yield under climate change* -- e.g. in China, yield stability for variety Favorita differs by location over a 12-year time period. While generally stable in Inner Mongolia, potential yield in Guangxi province indicates an unstable wide range, from 29 t/ha to 51 t/ha.
4. *Yield gap for future scenarios under climate change*-- 2040 scenarios across sites were analysed using temperature data; precipitation was excluded in the analysis due to data limitations especially for variability over time and location. In Meghalaya (India), 2040 potential yield is expected to drop from 39 to 30.5 t/ha. On the other hand in the northern highlands of Vietnam, there is a projected increase in potential yield from 32.5 to 41 t/ha.

RECOMMENDATIONS to IMPROVE YIELD GAP ANALYSIS

⇒ Undertake systematic collection and compilation of field-level data, while adjusting the parameters

⇒ Integrate diverse knowledge sources in the modelling exercise, including expert opinions from scientists and on-the-ground experiences from farmers and extensionists.

⇒ Recognize that scenario analysis cannot provide exact predictions yet they remain useful tools to aid decision making, e.g. targeting and priority-setting

⇒ Provide capacity building support to national partners through series of trainings from field data collection to application of simulation models and their eventual use of analytical outputs.

Discussion during the stakeholders' meeting to present workshop outputs

Workshop Facilitators and Resource Persons

1) Dindo Campilan, CIP-FoodSTART
2) Roberto Quiroz, CIP-Headquarters
3) Carolina Barreda, CIP-Headquarters
4) VS Mithra, CTCRI-India

Workshop Secretariat

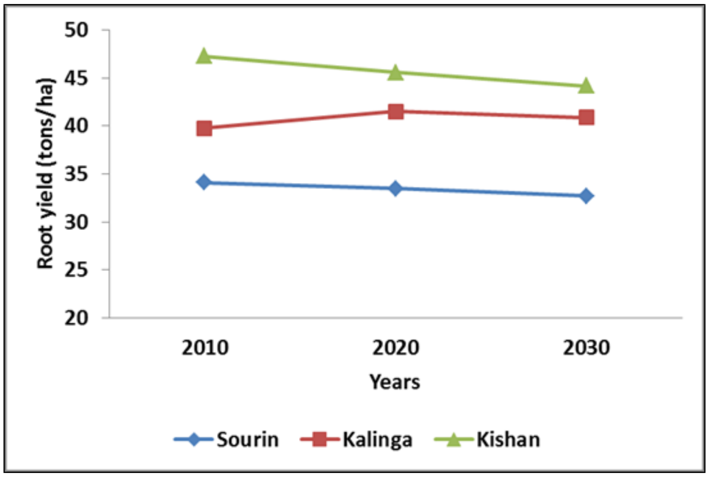
1) Marietta Nadal, 2) Christopher Wheatley, CIP-FoodSTART

Workshop Participants

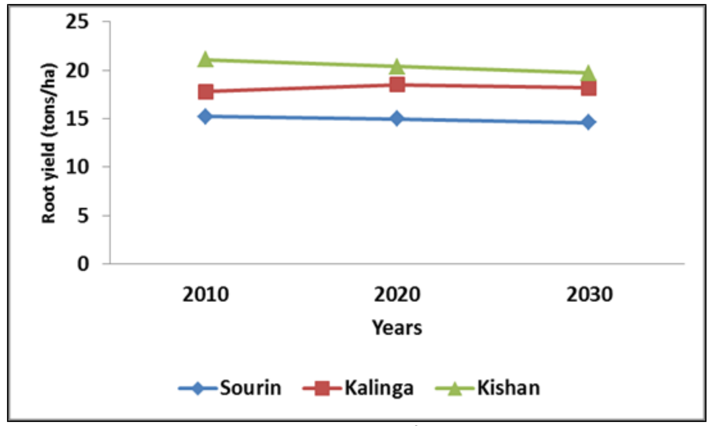
Li Ming	Institute of Biotechnology and Nuclear Technology, Sichuan AAS, Chengdu, China
Tang Zhouping	Cash Crops Research Institute, Guangxi Academy of Agricultural Sciences , China
Li Wenjuan	International Potato Center, China Center for Asia and the Pacific (CCCAP)
David Crook	International Potato Center, China Center for Asia and the Pacific (CCCAP)
Atxayavong Khamdy	Southern Agriculture and Forestry Research Center , Lao PDR
Dao Huy Chien	Potato Breeder's Network for Southeast Asia (PotNet-SEA), Vietnam
Nguyen Thi Thuy Hoai	Field Crops Research Institute, Vietnam
Nongmaithem Uttam Singh	ICAR Research Complex for NEH Region, India
Tjintokohadi	International Potato Center (CIP), Indonesia
Nguyen Thi Tinh	International Center for Tropical Agriculture (CIAT), International Potato Center (CIP), Vietnam
Jose Bacusmo	Visayas State University (VSU), Philippines
Arma Bertuso	International Potato Center (CIP), Philippines
Cynthia Kiswa	Northern Philippine Root Crops Research and Training Center (NPRCRTC)
Jocelyn Perez	Benguet State University (BSU), Philippines
Marlon Tambis	Philippine Root Crop Research and Training Center (PhilRootcrops)
Nedunchezhiyan Maniyam	Central Tuber Crops Research institute (CTCRI), India
Kusmana	Indonesia Vegetables Research Institute (IVEGRI)

Illustrative examples: SWEETPOTATO

1. Yield gap comparison between varieties as affected by crop fertilization (India)



Potential yield with fertilizer

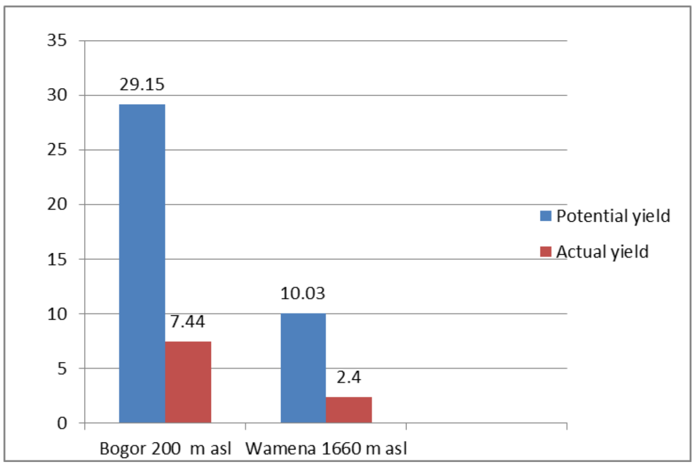


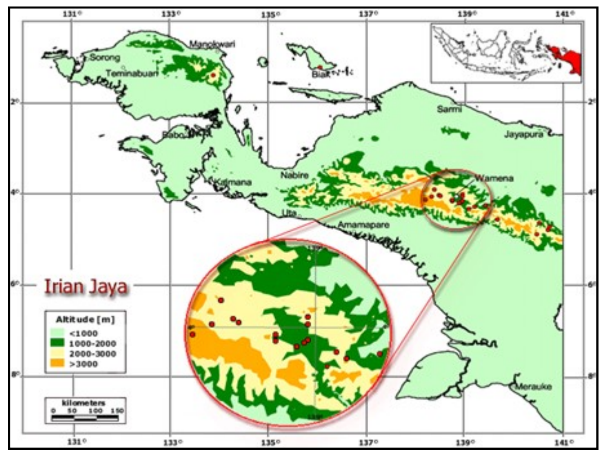
Potential yield without fertilizer

Reduction in potential yield gap

Sourin: 1.8 to 5.2% | Kalinga: 2.6 to 6.6% | Kishan: 3.1 to 14.3%

2. Yield gap comparison between locations for the same variety (Indonesia)

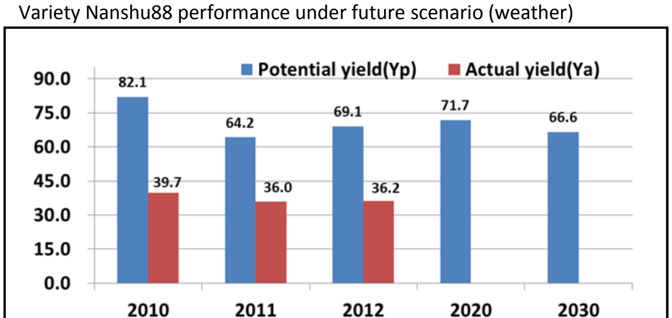




Variety Sukuh performance (potential and actual yield) under future scenario (weather) and multi-location

3. Yield gap comparison between farmers' actual yield and estimated potential yield (China)

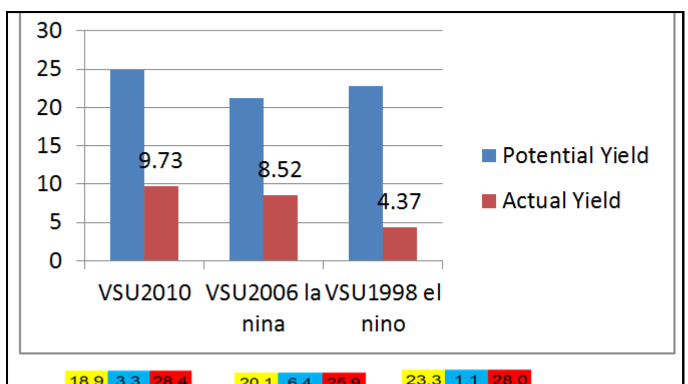
Variety Nanshu88 performance under future scenario (weather)



	2010	2011	2012	2020	2030
Yg	42.41	28.17	32.94		
%	51.68	43.89	47.66		
PYwater limitation	72.46	59.67	61.42	64.44	61.97

4. Yield gap comparison as affected by extreme weather events (Philippines)

Variety SP30 performance (potential and actual yield) under extreme weather conditions (La Nina, El Nino)



5. Yield gap scenarios as affected by climate change (Vietnam)

Variety		Hoang Long		97.1.1	
Location/**VietNam**		Hai Duong	Bac Giang	Hai Duong	Bac Giang
2012 (Winter)	Actual	*12.3*	*13.5*	*16.5*	*17.8*
	Potential	**44.9**	**42.0**	**39.9**	**48.4**
2020 (Winter)	Potential	**45.8**	**48.3**	**38.7**	**45.6**
2030 (Winter)	Potential	**42.4**	**42.5**	**35.9**	**43.2**

Soil type: Hai Duong: Clayloam and Bac Giang: Sandyloam

Fertilizer: 60:30:90

Growing times: 115 days

This FoodSTART-CCAFS brief on Yield Gap Analysis Workshop is prepared by Dindo Campilan. FoodSTART is an IFAD-funded regional grant program that aims to promote the role of RTCs in building more diverse and sustainable agri-food systems towards ensuring food security among poor producers and consumers in Asia Pacific and in the face of socio-economic and agro-environmental changes in the region.
(version April 2014)
For more details, please visit asia.ifad.org/web/foodstart
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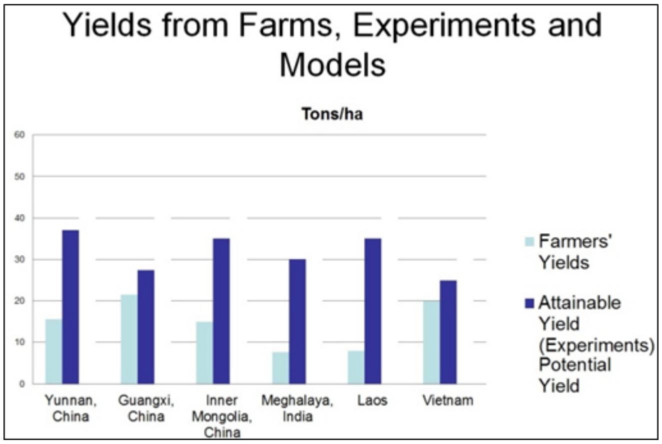
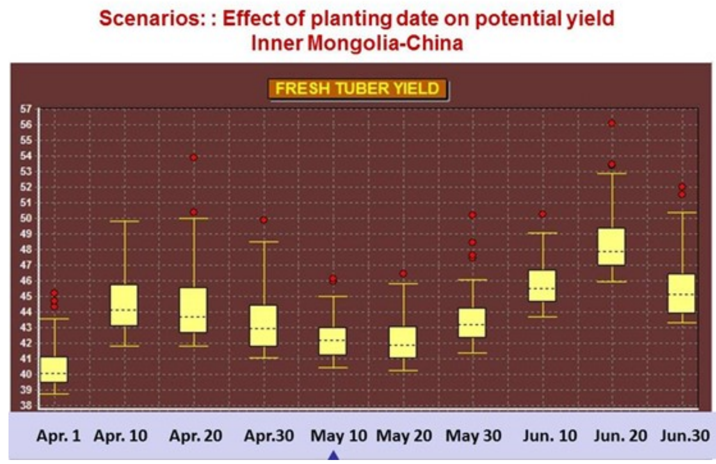
Illustrative examples: POTATO

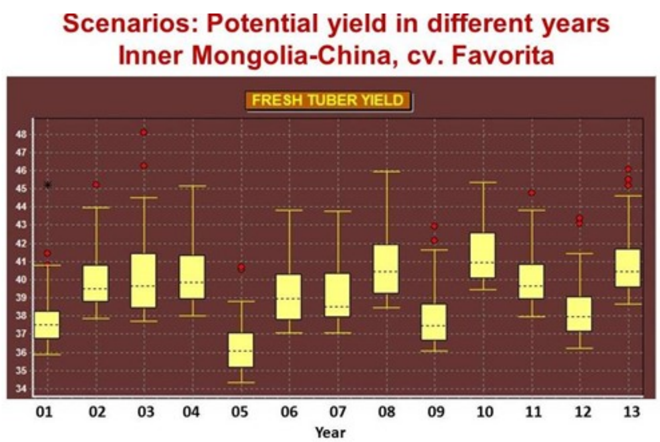
1. Yield gap comparison between actual farmers' yield and potential yields (China, Lao PDR, Mongolia, etc.)



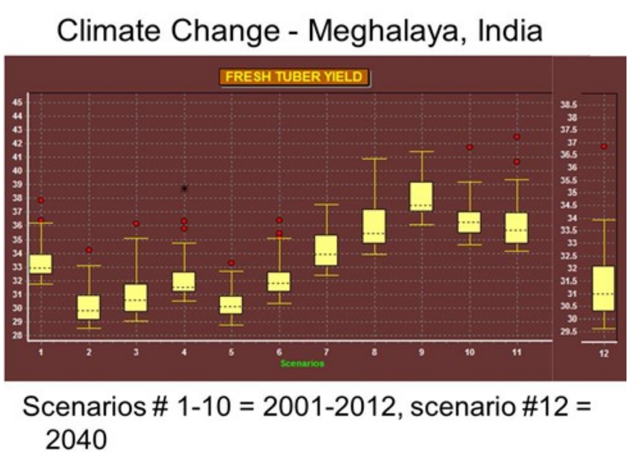
2. Yield gap comparison as influenced by planting date (China, India)

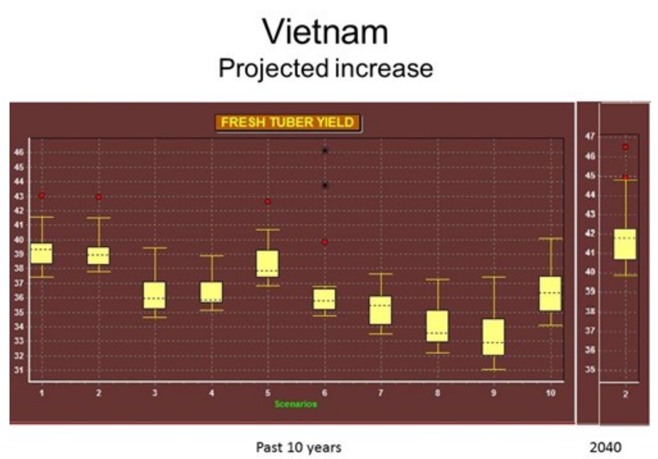


3. Yield gap comparison based in stability of potential yield under climate change (China, Inner Mongolia)



4. Yield gap for future scenarios under climate change (India, Vietnam)





ACTION PLANS

Key FoodSTART actions agreed with workshop participants and invited stakeholders –users include collaborating with:

1. National partners to further collect and consolidate agronomic data on potato and sweetpotato varieties, from previous and on-going field trials in key production areas in-country.
2. CRP RTB to undertake similar scenario analyses for other root and tuber crops (especially cassava, taro and yam), and for other sites/countries in Asia.
3. CIP's Integrated Crop and Systems Research Program to design a comprehensive, long-term training program, covering the entire process from data collection to use of scenario analysis outputs.
4. CRP CCAFS to promote the use of scenario analysis for other key agricultural crops , as a targeting and planning tool to support establishment of climate-smart villages in Southeast Asia.
5. IFAD to integrate scenario analysis outputs in the regional knowledge base on roots and tubers for food security, and in the design of follow-up research and development programs (e.g. FoodSTART Plus).
6. Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) to integrate scenario analysis in the mapping and targeting component of the soon-to-be launched sweetpotato value chain program.
7. Other national research and development agencies in the Philippines, as host country for the workshop, to improve quality of and access to general agricultural statistics and meteorological data.