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POTATO SCIENCE FOR THE POOR: CHALLENGES FOR THE NEW MILLENIUM

A Working Conference to celebrate the International Year of the Potato
25-28 March 2008
Cuzco, Peru

PROGRAM

24 March

15:00-18:00: Registration at the Conference venue, Hotel Libertador Palacio del Inka

25 March [Day 1]

OPENING SESSION: WELCOME AND OVERVIEW

08:00 Pamela Anderson, Director General, International Potato Center
Ren Wang, Director General, Consultative Group on International Agricultural Research
José Francisco Graziano da Silva, Assistant Director-General, Regional Representative for Latin America and the Caribbean, Food and Agriculture Organization of the United Nations
Ismael Benavides, Minister of Agriculture, Peru

08:30 Overview: Potato science for the poor
Pamela Anderson – International Potato Center

09:00 Introduction: International agricultural research and the global public goods challenge
Jurgen Voegele – Director, Agriculture and Rural Development, World Bank

09:20 Keynote Lecture: Targeting the poor and hungry
Graham Thiele – International Potato Center

10:00 Coffee Break

SESSION 1: INCREASING POTATO PRODUCTIVITY FOR THE AGRICULTURALLY BASED DEVELOPING WORLD

10:30 The importance of agricultural research for poverty reduction in Mozambique, with special reference to potato
C. Bias
Determinants of potato yield and profitability in Peru: a comparative analysis of coast and sierra regions
J. Velazco and V. Alva

Seed-tuber and soil-borne disease management in sustainable and intensive agricultural systems
L. Tsror

Challenges and opportunities for potato pest management in developing countries
J. Kroschel, M. Sporleider, J. Alcazar, V. Canedo, N. Mujica, O. Zegarra and R. Simon

11:45  Keynote Lecture:  Climate change as a risk to potato production
Marco Bindi – Universita degli Studi di Firenze

12:30  Lunch

14:00:  Emerging potato diseases: assessing future threats and global risk management
I. Barker, H. Gamarra, H. Juarez and G. Forbes

Applications of different molecular tools to detect candidate genes for useful traits
E. Ritter, I. Sánchez, J.I. Ruiz de Galarreta and M. Hernández

Improving abiotic stress resistance of cultivated potatoes: moving frost hardy genes from wild potatoes and making real progress using precise screening tools
J.P. Palta, J. B. Bamberg and S.E. Vega

Durable resistance to late blight in potato through the use of genes of wild species and prospects for resource poor environments
A.J. Haverkort

Potato seed: an everlasting challenge?
R. Cortbaoui

Supplemental calcium nutrition may have the potential of improving tuber yield of native potatoes in the Peruvian highlands
J.P. Palta, R. Gomez, A.H. del Rio, W. Roca, J.B. Bamberg, A. Salas and M. Bonierbale

15:30  Coffee Break – Poster Viewing
16:00  Keynote Lecture: **Domestication and diffusion of potato**  
David Spooner – USDA-Wisconsin

16:30  Working Groups: Formation and orientation (30 minutes)  
Charles Crissman, Deputy Director General for Research, CIP

18:00  Welcome Cocktail hosted by the Peruvian Ministry of Agriculture

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**26 March [Day 2]**

**SESSION 2: INCREASING SYSTEM RESILIENCE AND SUSTAINABILITY FOR THE TRANSFORMING DEVELOPING WORLD**

08:00  Keynote Lecture: **Underground assets: potatoes to improve the livelihoods of the poor**  
Ruth Meinzen-Dick – International Food Policy Research Institute

08:45  Keynote Lecture: **History lessons on vulnerability: the case of potato late blight in Europe**  
Jan Zadoks – Professor Emeritus, Wageningen University

09:30  **Potatoes: a tool for social inclusion and a link among cultures in Argentina**  
**Potatoes, climate, markets and gender in the livelihoods strategies of Altiplano communities in Bolivia**  
C. Valdivia and E. Jiménez  
**Participatory research and potato innovation systems: challenges and prospects**  
**Traditional agricultural technologies and their potential for sustainable potato production in the Andean region**  
A. Oswald, J Caycho, A. Arias and J. Andrade

10:30  Coffee Break – Poster Viewing

11:00  **Environmental vulnerability assessment of potato-based systems: tools and methods**  
R. Quiroz, C. Barreda, B. Condori, A. Posadas, C. Yarlequé, P. Zorogastúa, H. Heidinger and D. Sietz
Impacts of hydrological field interactions in an integrated assessment model for terraced crop systems in the Peruvian Andes
L. Claessens, J.J. Stoorvogel and J.M. Antle

Tillage erosion - a different way to look at soil erosion and conservation within steepland potato production in the Americas
K.H.D. Tiessen, G. Dercon, F. Sancho, D.A. Lobb and G.R. Mehuys

The efforts of the US Potato Genebank to make use of DNA-based markers to investigate the conservation and management of potato genetic diversity
A.H. del Rio and J.B. Bamberg

Temporal and spatial dimensions of potato genetic diversity in Huancavelica, central Peru
S. de Haan, M. Bonierbale, H. Juarez, J. Poma and E. Salas

Genomics and biodiversity: providing new opportunities for smallholder potato farmers

12:30 Lunch

14:00 Keynote Lecture: Pre-Columbian societies of the Andean region, associated with the domestication, intensive cultivation and dissemination of potato
Francisco Morales – International Center for Tropical Agriculture

14:45 Slide show on the Potato Park visit

15:30 Coffee Break - Poster Viewing

16:00 Working Groups (90 minutes)

18:00 Photography exhibition at the Inka Museum

27 MARCH [Day 3]

SESSION 3: MEETINGS WITH FARMER RESEARCHERS AT THE CUZCO POTATO PARK

07:00 Departure of buses from Cusco Plaza de Armas, near the Cathedral
09:30 Arrival to Park’s Community – Welcome: Park Farmers
10:00 The context: A. Argumedo
10:15 Native potatoes, climate change and adaptation
10:45 Potatoes, creative economy and local livelihoods
11:30 Native potato and muña drink break
12:00 Dialog: visitors and farmers
12:30 Visit to native potato fields
13:00 Departure to Potato Park interpretation center
13:55 Lunch
15:00 Acknowledgment to Branston: D. Nelson
15:10 Visit to Farmer Groups exhibits
15:30 Departure of buses from Potato Park to Cusco
17:00 Arrival at Cusco Plaza de Armas

28 MARCH [Day 4]

SESSION 4: INCREASING POTATO PROFITABILITY IN THE URBANIZED WORLD

08:00 Keynote lecture: Nutrition and health: two key issues for development
Manuel Peña – World Health Organization/PanAmerican Health Organization

08:45 Keynote Lecture: Doing well by doing good
Carole Munro – Vice President, Wellness Project LIFE, McCain Food Limited

09:30 Collective action for market chain innovation in the Andes
A. Devaux, D. Horton, C. Velasco, G. Thiele, G. López, T. Bernet, I. Reinoso and M. Ordinola

T’ikapapa – a concrete case to link small-scale Andean farmers to new market opportunities using potato biodiversity
K. Manrique, M. Ordinola, T. Bernet, A. Thomann and A. Devaux

The potential for small-scale farmers to access national and regional markets for fresh and frozen potato chips in Burundi, Ethiopia, Kenya, Rwanda Tanzania and Uganda
B. Lemaga, J. Nsumba, A. Bombom, A. Tesfaye, G. Okoboi and G. Thiele

Environmental pressures on the potato supply chain in the United Kingdom
D.G. Nelson

10:30 Coffee Break – Poster Viewing
11:00 Fighting poverty in Ecuador through potatoes: the FORTIPAPA experience
I. Reinoso

The climate as a factor in determining the profitability of the potato crop in five areas of the Peruvian coast and sierra
H. Venero and V. Alva

Native potato farmers’ access to high value markets
A. Gandarillas, S. Arandia, and J. Blajos

11:45 Open Discussion

12:30 Lunch

14:00 Working Groups (90 minutes)

15:30 Coffee Break - Poster Viewing

16:00 Closing Session
Reports from Working Group Chairs
Open Discussion

Final Remarks: Jean-François Ghyoot, FAO
Final Remarks: Pamela Anderson, CIP
Determinants of potato’s yield and profitability in Peru: a comparative analysis of coast and sierra regions

J. Velazco and V. Alva

Potato accounts for the major part of agricultural production in Peru. Traditionally, potato has been sown in the sierra (mountain) region; however, in the last decades, more production is being seen in the coastal regions, due basically to significant improvements in yields.

Between 2004 and 2006, the Ministry of Agriculture implemented a profitability survey (ERENTA) in three of the main valleys of potato production in the coast: Chancay Huaral, Supe – Pativilca – Fortaleza and Tambo, and in two of the main production districts in the Sierra: Panao and Acocro (both located in two of the poorest regions of the country). ERENTA was implemented by means of multiple visits and gathered information about technology, relations to market and profitability (monetary and non-monetary) of 260 plots.

This paper is composed of five sections. The first one gives a brief description of ERENTA. Second, the importance of potato sowing in selected valleys/district is explained. The third section deals with technology, profitability and the differences between the coast and the sierra. The fourth section presents the methodology to estimate determinants of yield and profitability. Finally, the estimations made are presented and policy implications resulting from the analyses are discussed.

The main findings highlight the need to implement policies to increase the certified seed index, strengthen the role of the plant health system, develop a strategy to guide the producer in fertilization, seeds, plant health and management in the post harvest period. Another finding is the need to determine the optimal level of production that allows producers to reach positive profitability levels and zones that are competitive in the production market. Using this information a sowing alert system could be implemented to reduce the adverse impact of overproduction in farm prices. The results also show the need to promote an organization among producers to foster the development of some markets like the loan market and the technical support market.

Ministerio de Agricultura, Perú.
Seed, tuber and soil-borne disease management in sustainable and intensive agricultural systems

L. Tsror

A 20-year survey conducted at Gilat, Israel showed that most imported seed lots registered as certified were contaminated with latent or active infections caused by various bacteria and fungi.

In a long-term survey (1999-2008), *Ralstonia solanacearum* was not observed in any of the imported lots. Common scab was detected in most of the imported lots; 64% were contaminated at moderate or high levels, whereas only 5% of the domestic lots were contaminated at these levels. Black scurf was detected in most of the imported lots; on average 37%, 33% and 1% of the lots were contaminated at low, moderate and high levels, respectively. Most of the domestic lots were either disease-free or had a low to moderate disease incidence (15%). Silver scurf was detected in most of the imported lots; on average, 11%, 45% and 32% of the lots were contaminated at low, moderate and high levels, respectively. Half of the domestic lots were disease-free; 12%, 29% and 3% of the lots were contaminated at low, moderate and high levels, respectively. Black dot was observed in a considerable portion of the shipments from Holland (54% on average during all the years of survey), and from France (25% on average). The shipments from Germany and Scotland were infected at low levels (16% and 5%, respectively). In domestic lots, black dot incidence was low (3%). *Verticillium dahliae* was monitored in all domestic lots; 62% of the lots were disease-free, whereas in 29% of the lots the level of infection was <5%, and in 9% of the lots the level was >5%. Representative samples were taken from imported susceptible cultivars; 38% of the tested lots were *V. dahliae*-infected in 2000, 0% in 2001, and 10% in 2002.

An integrated disease-management approach that includes cultural, biological and chemical control methods, in the field and in storage, is necessary for long-term control of skin blemish diseases. The fungicide TBZ was used for silver scurf control until the 1980s, but due to the high frequency of resistance, imazalil has become the main fungicide used on seed tubers in Europe. However, *Colletotrichum coccodes* is not sufficiently controlled by imazalil, suggesting another reason why black dot became a major pathogen on potato. Additional fungicides, e.g., prochloraz, fludioxonil and azoxystrobin, that control both pathogens are being introduced. Adequate control of the skin blemish diseases with very low tolerance for market access is highly problematic, and will require integrated strategies combining all currently available control methods.

High quality seed tubers will prevent yield damage in the short term and field infestation in the long run, so when using contaminated seed tubers an efficient control should be applied to minimize potential damage.

Department of Plant Pathology, Agricultural Research Organization, Gilat Research Center, M.P. Negev, 85280 Israel.
Challenges and opportunities for potato pest management in developing countries

J. Kroschel, M. Sporleder, J. Alcazar, V. Canedo, N. Mujica and O. Zegarra

Potato is highly productive, but losses through insect pests during the cropping and storage periods are high. In an attempt to reduce losses, potato farmers spend approximately US$1 billion annually on pesticides worldwide. In developing countries the unilateral use of highly toxic insecticides is often common practice. A rapid built-up of pest resistance to pesticides and serious health threats of pesticides to farmers, consumers and the environment has increased interest in safer control alternatives through the development of integrated pest management (IPM).

This paper demonstrates the potato pest problems in the tropics and subtropics worldwide and highlights major achievements in potato IPM. It underline the need for a systems approach in developing effective and sustainable IPM practices in a joint effort among scientists, extension workers and farmers. It explores opportunities for potato IPM based on a better understanding of potato agroecologies, the use of ecological concepts supported by insect modeling, the use of biorational products, biotechnology and biophysical methods.

International Potato Center (CIP), Apartado 1558, Lima 12, Peru.
Emerging potato diseases: assessing future threats and global risk management

I. Barker, H. Gamarra, H. Juarez and G. Forbes

Successful crop cultivation is ultimately about risk management. The burden of crop losses due to plant disease (biotic threats) falls most heavily on developing countries. Estimated shortfalls on attainable yield through disease are 16% in Sub-Saharan Africa but only 10% in Europe. Outbreaks of crop disease can threaten national food security, displace populations and damage economies that are highly dependent on agricultural export income. The potato crop is no exception and potato cultivation is subject to a wide range of pests and diseases including emerging infectious diseases. Key drivers of these recent, current and potential epidemics include both globalization of trade, changes in cropping practice and potentially climate change. Current recent examples include the 2003 outbreak of potato late blight in the Western Highlands of Papua New Guinea, the emergence of zebra chip disease in North and central America and the spread of potato yellow vein virus in the Andes.

Strategies to combat plant disease outbreaks should involve early intervention either to stop diseases spreading or to prevent them in the first place. Early detection of the appearance of disease or disease causing agents followed by rapid and accurate identification of these agents is essential if correct control measures are to be deployed. This is particularly true for entirely new diseases where novel control strategies may have to be developed alongside characterization of novel agents. In outbreak situations, monitoring of a known problem will involve the same systems of detection and identification and is important to inform priorities on focusing effort. Technological and advances in so-called detection, identification and monitoring (DIM) systems along with progress in pathogen genomics, bioinformatics, mapping (GIS) and modelling offers unparalleled opportunities for future successful intervention in future plant disease outbreaks.

1 International Potato Center (CIP), P.O. Box 1558, Lima 12, Peru.
Applications of different molecular tools to detect candidate genes for useful traits

E. Ritter, I. Sánchez, J.I. Ruiz de Galarreta and M. Hernández

Different molecular tools have been applied to detect resistance or response genes to various potato pathogens and quality genes. These include transcriptome mapping based on the cDNA-AFLP technique combined with co-location analyses between QTLs and TDFs, the use of differential cDNA-AFLP and microarray analyses. Successful examples will be presented in each case.

A transcriptome map containing around 700 cDNA markers was constructed using the cDNA-AFLP technique. This map was anchored to the bins of a high-density reference map of potato. Subsequently over 200 published QTL and genes were projected onto this map. cDNA markers which are co-located with published QTLs for pathogen resistance present potential candidate genes controlling the trait. Such bands were cloned, sequenced and homology searches were performed. Several interesting homologies were detected that have a relevant biological meaning.

The differential cDNA-AFLP technique was applied to detect resistance or response genes for nematode infections (*Globodera pallida*), for *Phytophthora infestans* infections and for water stress in a set of *Solanum* wild species. In all three case studies some differentially expressed bands that were cloned and sequenced showed significant homologies with known resistance genes or stress proteins.

Microarray analyses were applied to monitor differential expression of cDNAs in *Solanum brachistotrichum* after inoculation with *G. pallida* and in five different *Solanum* wild species after infection with *P. infestans*. Several cDNAs with homologies to known resistance genes were detected in all cases. In the case of *P. infestans* also a comparative response analyses was performed.

NEIKER – Instituto Vasco de Investigación y Desarrollo Agrario, Aptdo. 46, Vitoria, Spain.
Improving abiotic stress resistance of cultivated potatoes: moving frost hardy genes from wild potatoes and making real progress using precise screening tools

J.P. Palta, J. B. Bamberg and S.E. Vega

The common cultivated species *Solanum tuberosum* is frost sensitive and is killed at temperatures below -2.5°C. It has been estimated that increasing frost hardiness by 1-2°C would increase in potato yield by 26-40% in the Altiplano (Peru and Bolivia), representing covering 63 000 ha of potatoes. Because of the threat of frost, 60% of this area is planted with bitter potatoes that are hardy to frost yet cannot be consumed fresh. Early work showed that several wild potato species are hardy under normal growing conditions (non-acclimated frost hardiness: NAF). For example, *S. acaule* can survive temperatures as low as -5°C. In addition wild species such as *S. commersonii* are able to increase frost hardiness after a brief exposure to cold temperatures (acclimation capacity: ACC). This species can acclimate in 7 days from -4 to -12°C.

We demonstrated that NAF and ACC are independent components under separate genetic control. These results suggested that potato frost hardiness can only be improved through precise selection for both of these components under controlled environments. During the last 15 years, using somatic hybrids of *S. tuberosum* and *S. commersonii* as well as sexual hybrids with *S. acaule*, we have made significant progress in moving frost hardiness to the cultivated type. These studies utilized precise screening under a controlled environment. Advanced breeding lines with improved frost hardiness (NAF and ACC) as well as tuber yield comparable to cultivated parents have been identified. We are now in the process of utilizing these materials in breeding as well as testing these lines in the field.

University of Wisconsin-Madison, WI 53706, USA
Durable resistance to late blight in potato through the use of genes of wild species and prospects for resource-poor environments

A.J. Haverkort

Annually a conservative estimate of 20% of total attainable production of potato is lost due to late blight (costs of control and damage). In rich countries chemical control is less successful as late blight pressure increases and there is societal resistance against the use of environmentally unfriendly chemicals. In resource-poor countries chemicals are too expensive and often not available. Current breeding programs have not been able to markedly increase the resistance levels of potato varieties. New scientific approaches may yield genetically modified marker-free potato varieties (either trans- and/or cisgenic, the latter signifying the use of indigenous resistance genes) as improved variants of currently used varieties showing far greater levels of resistance. There are large scientific investments needed to develop such improved varieties that may have great economic and environmental impact. Here we present an approach, based on (cisgenic) resistance genes that will enhance the impact. It consists of the following issues/steps/themes:

- the detection of R-genes in the wild potato gene pool and their function related to the various aspects in the infection route and reproduction of the late blight causing pathogen;
- cloning of natural R-genes and transforming cassettes of single or multiple (cisgenic) R-genes into existing varieties with proven adaptation to improve their value for consumers;
- spatial and temporal resistance management research of late blight of the cisgenic genetically modified (GM) varieties that contain different cassettes of R-genes to avoid breaking of resistance and reduce build up of epidemics;
- communication and interaction with all relevant stakeholders in society and transparency in what research is doing. One of the main challenges being to explain the different nature and possible biological and legislative improvement of cisgenic GM crops in comparison to transgenic GM crops.

Besides the presentation of this research approach that started in 2006, some preliminary results issues related to intellectual property and the needs of developing countries will be discussed.

P.O. Box 16, 6700 AA Wageningen, the Netherlands.
Potato seed: an everlasting challenge?

Roger Cortbaoui

Availability of seed remains one of the main constraints to the large scale adoption of the CIP-bred or CIP-derived improved varieties. This is in spite of the fact that research on seed systems has featured (constantly over that last 30 years) in the agendas of CIP and the majority of its partners.

Several CIP-supported seed production ventures in Africa, Asia and LAC are reviewed from the following points of view:

- The early exaggerated role of government support and leadership in seed production
- The over-emphasis on laboratory technologies (micro-propagation, disease detection, etc.) and the limited efforts in field management processes and techniques.
- The almost exclusive focusing of seed programs on the phytosanitary status of the seed and the neglect of its physiological condition.
- The gradual involvement of civil society organizations in seed production and trade.
- The adaptation to the globalization of trade of agricultural products.
- The emergence of innovative ventures, in agricultural production and marketing, based on the participatory market chain approaches.

Lessons learned from the few successful cases and the numerous less successful ones will be drawn and serve as the basis of a revised road map for seed production research and development.

International Potato Center (CIP), P.O. Box 1558, Lima 12, Peru.
Supplemental calcium nutrition may have the potential of improving tuber yield of native potatoes in the Peruvian highlands

J.P. Palta¹, R. Gomez² A.H.del Rio¹, W. Roca³, J.B. Bamberg¹, A. Salas² and M. Bonierbale²

Previous research conducted at the University of Wisconsin has demonstrated that in season calcium fertilization can improve tuber quality of several US cultivars including chipping, russet and red potatoes. In addition, calcium application has been shown to reduce the adverse effects of environmental stresses. However, no studies have been conducted on the response of native potatoes grown in the Andean highlands. Many locations in the Andes tend to be acidic and so are low in available calcium.

The present study was initiated to determine the response of native potatoes to calcium nutrition. For this purpose the experiment was conducted at San Jose de Aymara (potato farming community near Huancayo, Junin, Peru; approximate elevation 4000 m asl). 20 landraces and 5 cultivars were planted in December 2005. Locally available gypsum was used as a source of calcium and incorporated into the soil at planting. Treatments were replicated three times. At harvest all tubers were removed by hand and weighed. Overall results showed that calcium application tended to increase yield in nearly all the materials tested. However, this increase was not statistically significant in every case. There was a significant increase in yield in 7 landraces and 3 cultivars. Tuber yield of cultivar Mariva and Perricholi was increased by 30 and 40%, respectively as compared to control. The increase in yield by calcium treatment was 20-50% for the native potatoes. Possible influence of calcium treatment on nutritive value is being investigated. These results are very encouraging and suggest that local supplement can be used in the highlands to improve yield of native potatoes.

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²International Potato Center (CIP), P.O. Box 1558, Lima 12, Peru.
Potatoes: a tool for social inclusion and a link among cultures in Argentina

F. Sosa¹, S. Capezio², S. Rigato³, M.C. Monti², K.A. Okada³, M.L. Tejón⁴ and M. Huarte³

Socially excluded rural and urban communities are often forgotten by state aid. Empowerment through training and development of self-sustainable economic activities is a way to cope with the lack of opportunities and aid. The great variability in the characteristics of these voiceless populations creates the need for a sufficiently attractive model that promotes cultural pride, to some extent exerts an intellectual challenge among the actors, creates opportunities and develops social recognition and human promotion. Society in general has to take part in these communities as a fundamental human right and therefore facilitate the construction of social networks.

Not surprisingly, the activity of growing and marketing potatoes has most of these characteristics. Since 2003, INTA projects have worked in the northwestern Coya aborigine communities of Argentina where potatoes have a strong cultural tradition. Seed technology adapted to subsistence farmers, participatory breeding, in situ conservation of ancient varieties and community-based organization were promoted. We present the results of this work.

Other native communities, such as the Mapuche aborigines in Patagonia, had potatoes among their traditional staple crops, but they have lost most of the associated culture and the crop has been lost. Some actions on variety evaluation and participatory breeding were initiated and are described. On the other hand, the Toba aborigines in the Chaco region did not have the culture of growing potatoes but these days are suffering severe malnutrition and a process of aculturalization, lack of jobs and life perspective. There are indications of their willingness to grow potatoes and rescue old intercultural and commercial exchanges with the Coyas. Training in growing potatoes in family gardens and intercultural exchanges is giving these native communities a different lifestyle using the potato model.

Finally, preliminary work with mentally handicapped urban patients and prisoners reveal their interest and motivation for learning about potatoes, transforming this “hidden treasure” into a common denominator to all these forgotten human populations. A project linking these frequently excluded communities through learning and exchanging knowledge about potatoes is described.

¹ Abra pampa Experiment Station, INTA, Jujuy, Argentina.
² College of Agricultural Sciences, National University of Mar del Plata (UNMdP), Argentina.
³ Balcarce Experiment Station INTA, Buenos Aires, Argentina.
⁴ College of Health Sciences and Social Services, UNMdP, Argentina.
Potatoes, climate, markets and gender in the livelihoods strategies of Altiplano communities in Bolivia

C. Valdivia and E. Jiménez

Adapting to Change in the Andes, a research collaboration project in the Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANREM CRSP) is studying how climate and markets are drivers of change in Altiplano ecosystems, through impact on the environment and on human social systems. Two working hypotheses inform the research. The first focuses on the system drivers. On the one hand climate change, with increased variability and extreme events, has increased the risks in production and directly on livelihoods and wellbeing. On the other, rural communities in the Altiplano have faced difficulties with markets for their products due to partial integration and high transactions costs. The second focuses on agency, and how participatory approaches develop knowledge and skills that increase capabilities and agency to negotiate these risks, and develop strategies that reduce the risks posed by both drivers. For the strategies to be sustainable the natural capital must grow. One of the elements of this capital is the biodiversity of potatoes and other Andean tubers.

This presentation focuses first on the importance of potatoes and the various varieties in the livelihoods of households in the Altiplano, analyzing a sample of 360 households in two distinct regions of the Bolivian Altiplano, where potato varieties are produced and play a dual role in the household economic portfolio –market and consumption- along with other native crops, and livestock. Because women and men in households may engage in different activities, gender differences regarding perceptions about fears and risks, livelihood wellbeing concerns, and market participation are assessed. The analysis seeks to identify which livelihood strategies are more resilient to shock, and how this is explained by the capitals and abilities. Which livelihood strategies are more resilient to climate and market shocks, which capitals are significant, and how these are reflected in how people perceive risks and fears are analyzed. Five capitals, natural, cultural, social, economic, human, are operational in the quantitative analysis of their effect over perceptions of risk and fears, and income generation. Diversity of potatoes managed for consumption and markets is a measure of the natural capital.

1University of Missouri, Columbia, USA.
2Universidad de la Cordillera, Bolivia.
**Participatory research and potato innovation systems: challenges and prospects**


Approaches related to agricultural research and development have been changing over the years. The technology transfer approach was prevalent in the 1970’s, then the farming system research, followed by the agro-ecology approach and the beginning of participatory research in the 1980’s. In the 1990’s and in recent years, new approaches have attempted to explain agricultural innovation processes, focusing on the participation of multiple stakeholders. With the aim of contributing to understand how this concept can be applied in a practical way, a study was conducted in Bolivia, Ethiopia, Peru and Uganda during 2004 and 2007 with the specific objectives of characterizing the potato innovation systems in terms of their components, interactions and main challenges, and understanding the factors that influence scaling-up and out of participatory methods. Results indicate that the potato innovation systems are highly variable in terms of type, number and role of components, with a still strong and conventional government role in the case of Ethiopia, a flexible government-NGO role in Uganda, to an almost inexistent government role in Bolivia and Peru, where farmer organizations, NGO and the private sector provide dynamism to the system. The potato innovation systems in the different countries also share commonalities such as the scarcity of interaction mechanisms among components. Costs and benefits of participatory research were gathered at farmer, facilitator and institutional levels, helping to understand the factors that influence the scaling-up and out of participatory methods. The identification of strengths and weaknesses in each system and the factors influencing participation allowed the definition of potential entry points for research and development interventions.

1 International Potato Center (CIP), P.O. Box 1558, Lima 12, Peru.

2 CARE, Peru.

3 PROINPA, Bolivia.

4 ASAR, Bolivia.

5 Ethiopian Institute of Agricultural Research (EIAR), Ethiopia.

6 Self Help Development International (SHDI), Ethiopia.

7 National Agricultural Research Organization (NARO), Uganda.

8 AFRICARE, Uganda.
Traditional agricultural technologies and their potential for sustainable potato production in the Andean region

A. Oswald¹, J. Caycho¹, A. Arias² and J. Andrade³

Farmers in the central Andean highlands use different traditional technologies for preparing the seed bed for the potato crop. These technologies are based on the use of the Andean foot plow or chaqitaklla. Each of these technologies has specific characteristics adapted to the agro-ecological conditions of highland zones and shows interactions with the genetic background of the varieties used (improved, native or bitter potato) with the fertilizer and pest management and local climatic conditions. Furthermore, they require different levels of labor input and management of the crop. Consequently, they also influence plant development, resistance to biotic and abiotic stresses and eventually yield.

¹International Potato Center (CIP), P.O. Box 1558, Lima 12, Peru.
²International Potato Center (CIP), Huancayo, Peru.
³International Potato Center (CIP), Quito, Ecuador.
Environmental vulnerability assessment of potato-based systems: tools and methods

R. Quiroz\textsuperscript{1}, C. Barreda\textsuperscript{1}, B. Condori\textsuperscript{2}, A. Posadas\textsuperscript{1}, C. Yarlequé\textsuperscript{1}, P. Zorogastúa\textsuperscript{1}, H. Heidinger\textsuperscript{1} and D. Sietz\textsuperscript{1}

The potato is very sensitive to changes in temperature and relative humidity. These changes have both direct and indirect effects on potato productivity. The response of the crop to changes in temperature is driven by changes in emergency, metabolic, photosynthesis and respiration rates, and total dry matter production. The temperature change will decrease potato yield whenever the values in critical stages depart from their optimum range and increase otherwise. Potato growth models are used to simulate how changes in the climate are expected to affect the performance of different potato varieties. Once the models are calibrated the assessment is conducted for target regions. Geospatial data is needed to conduct these assessments. Tools and methods to generate soil, topography, and weather data for regions with high spatial heterogeneity are discussed. Impact of management decisions on key environmental variables will be presented. Management options derived from local case studies provide details on specific processes, but face the question of how relevant they are for similar cases in other regions. For improving the transfer of options from pilot to other regions, environmental vulnerability can be analyzed on an intermediate level to adequately reflect local and global dynamics. To integrate the knowledge across different levels, typical patterns of vulnerability can reveal important relations between the components of environmental vulnerability and adaptation options.

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Impacts of hydrological field interactions in an integrated assessment model for terraced crop systems in the Peruvian Andes

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Agricultural systems research is focussing increasingly on the spatially complex, dynamic interactions between bio-physical and socio-economic sub-systems. In this paper we investigate the interactions among terracing, water availability and land use decisions, and their impact on farmers’ incomes in a study area in the Peruvian Andes. To do this we link a model simulating water redistribution at the catchment scale to a site-specific model of land use and management, using the Tradeoff Analysis modeling system (TOA). We tested the hypothesis that these interactions affect the simulated spatial distribution of impacts from changes in technology (terracing, crop productivity) as well as aggregate impacts. The results indicate that taking these interactions into account does not affect the aggregate impacts but they do result in different spatial patterns of land use and farm income in the study area. An important new finding is that the simulated effects of terracing on productivity are substantially affected by the spatial patterns of terracing, with up-slope terraces having a substantial negative effect on the productivity of terraced fields downslope. These findings suggest that although field-level interactions may average out in aggregate analysis, the effects they have on the spatial pattern of land use allocation and income may be relevant for analysis of environmental impact and equity studies in which the spatial distribution of effects is important.

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Tillage erosion: a different way to look at soil erosion and conservation within steepland potato production in the Americas

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Soil erosion from cultivated lands is a problem that continues to threaten the sustainability of both subsistence and commercial agriculture in many parts of the Americas. Previous erosion studies have focused primarily on rainfall-induced erosion and/or the action of wind – however, these are not the only erosion processes that threaten the sustainability of agricultural production around the world. Recent studies have demonstrated that the direct movement of soil by tillage operations is another significant erosive process, and is expected to be of greatest concern in regions where intensively tilled crops – such as potatoes (Solanum tuberosum L.) – are grown on topographically complex landscapes.

Potatoes are a major crop throughout South, Central and North America. Yet, despite its global importance, very little research has been conducted on the potential for, and impact of, tillage erosion within potato production under steepland agricultural systems. This presentation will focus on results from three recent research programs that looked at tillage translocation and tillage erosion (by mechanized and animal-powered tillage) within steepland potato/vegetable production in Ecuador, Costa Rica and Canada. Soil erosion losses of 100-250 Mg ha⁻¹ pass⁻¹ were measured for mechanized tillage operations in Canada (alternating-direction tillage systems) and in Ecuador and Costa Rica (one-way disc tillage systems). The traditional animal-powered tillage systems used in Ecuador (i.e., the ard plough) caused less tillage erosion than mechanized systems, however, tillage erosion due to animal-powered tillage is still an extremely important process – especially on small, steep fields and when soil is only thrown down the slope. This presentation will also examine the impact that tillage erosion has on the spatial variability of soil properties and crop yields that are evident in many fields across the Americas. We believe that a reduction in all soil erosion agents – tillage, water and wind – is necessary to reduce soil losses and maintain the long-term viability of potato production worldwide.

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The efforts of the US Potato Genebank to make use of DNA-based markers to investigate the conservation and management of potato genetic diversity

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The constant changes in habitat conditions have made preservation of biodiversity a very important task. In particular, the critical objective of all potato genebanks is to maximize the acquisition and preservation of genetic diversity. Thus, a key aspect identified by the United States Potato Genebank (USPG) and the Association of Potato Intergenebank Collaborators (APIC), is that there is very limited empirical scientific information about the potential factors affecting genebanks’ methods for acquiring and preserving diversity. The increased use of DNA-based markers has made it possible to develop precise genetic comparisons and objective testing of assumptions upon which many current genebank methods are based. In past years, USPG efforts have been focused on research targeting different questions on conservation strategies and natural organization of diversity. We are presenting here a selection of our scientific findings. The studies to present are: 1) comparing the genetic similarity of populations in the genebank with those re-sampled from the exact original locations many years later, 2) determining usefulness of populations with illogical or missing classification 3) testing genetic integrity after years of seed increases 4) assessing the organization of diversity at natural habitats 5) testing genetic equivalence between genebanks’ duplicate holdings. These studies represent important efforts toward efficient potato genetic conservation. However, we conclude that further research and continuing cooperation among genebanks is needed. In this way, more common problems can be identified and the best techniques for maximum conservation of potato genetic diversity can be devised and implemented.

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Temporal and spatial dimensions of potato genetic diversity in Huancavelica, central Peru

S. de Haan¹, M. Bonierbale¹, H. Juarez¹, J. Poma² and E. Salas¹

Diverse components of the annual, medium and long-term spatial management of improved, native-bitter and native-floury potato cultivars were researched using a combination of methods, including GIS, structured surveys, field sampling exercises, a GxE trial, and molecular characterization of a large in-situ and a geographically restricted ex-situ core collection. Annual spatial dynamics is characterized by two complementary cropping calendars, field scattering practices that distribute genetic diversity unevenly across the agricultural landscape and conscious farmer GxE management of generally versatile cultivars according to perceived levels of risks in specific agroecologies.

Medium-term spatial management between 1995 and 2005 shows that the total cropping area dedicated to improved cultivars in Huancavelica has grown fast while the cropping area reserved for floury and bitter landraces has remained more or less stable. While areas of improved cultivars are proportionally growing fastest at extremely high altitudes between 3900 and 4350 m asl, overall cropping intensity or fallowing rates are inversely correlated to altitude. Long-term spatial management over a 30-year period evidences the gradual disintegration of sectoral fallowing systems rich in landrace diversity. Where sectoral rotation designs survive local innovations have been adopted. No evidence of genetic erosion was found with analysis of molecular variance (AMOVA) showing that 98.8% of the total number of alleles encountered is shared between in situ and ex situ collections.

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Genomics and biodiversity: providing new opportunities for smallholder potato farmers

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Four Andean breeding programs and CIP have recently completed a 3-years project sponsored by the government of Germany. The project goal was to contribute to improving income, food security, human health and environmental well being by providing resource-poor farmers with effective technological options for controlling late blight disease and potato virus Y. New sources of resistance from native wild and cultivated species were introduced and advanced in the collaborating breeding programs and molecular techniques were applied to assess the resistant germplasm. Additional activities included exchange of improved clones among collaborators, seed multiplication programs, participatory evaluation, diagnosis of variety diffusion pathways and GIS characterization of potato production zones aimed at accelerating the delivery and adoption of new varieties of high yielding, LB/virus Y resistant varieties by Andean farmers. As a result of the project complementary efforts, the potato varieties Iniap-Estela, Iniap-Santa Ana and Iniap-Natividad were released in Ecuador; the new varieties Ruby and Esmeralda have been diffused and adopted in different areas of Colombia; potential late blight resistant varieties have been selected in Bolivia while clones combining late blight and virus resistances have been identified in Peru. DNA markers for virus Y and LB resistance were tested and are available for future research.

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Collective action for market chain innovation in the Andes

A. Devaux, D. Horton¹, C. Velasco¹, G. Thiele¹, G. López¹, T. Bernet¹, I. Reinoso² and M. Ordinola³

The Papa Andina network in Bolivia, Ecuador and Peru employs two novel forms of collective action to foster market chain innovation in the Andes. The participatory market chain approach (PMCA) and stakeholder platforms bring small potato producers together with market agents and agricultural service providers to identify common interests, share market knowledge and carry out joint activities to develop new business opportunities.

Using these forms of collective action, new market niches have been developed for Andean native potatoes grown by poor farmers in remote highland areas. Social networks have been developed that stimulate technical and institutional innovations, benefiting small farmers as well as other market chain actors. This paper describes Papa Andina’s experiences with collective action for market chain innovation. It then discusses how this contributes to our understanding of collective action generally, and policy implications for research and development organizations, including Papa Andina.

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T’ikapapa: a concrete case to link small-scale Andean farmers to new market opportunities using potato biodiversity

K. Manrique, M. Ordinola, T. Bernet, A. Thomann and A. Devaux

Native potato varieties have been crucial for the subsistence and survival of Andean farmers for centuries. In today’s globalized world, they are a unique asset and comparative advantage of marginalized Andean communities. Put into a value chain context, native potato biodiversity has underexploited potential to improve the livelihood of farmers and contribute to sustainable development in the Andes - a potential which T’ikapapa has contributed to realize.

T’ikapapa is a marketing concept and work scheme that resulted from collective action, innovation and public-private partnership promoted by CIP’s project INCOPA/Papa Andina. Through T’ikapapa, small-scale Andean farmers accessed high value niche market opportunities, which added value to their native potato production and increased their income, while providing a business case for the social responsibility of the modern retail food industry. T’ikapapa has also contributed to raise public awareness of and interest in the conservation of Andean potato biodiversity through commercial use. Eventually, it fed back to the research agenda on production and post-harvest technology.

This paper describes the conceptual framework behind T’ikapapa’s creation, presents a first balance of outcomes at the commercial, institutional and technological levels, discusses shortcomings and outlines remaining challenges for developing T’ikapapa into a replicable marketing scheme to link small farmers to market in a sustainable way as part of a poverty reduction strategy.

International Potato Center (CIP), Apartado 1558, Lima 12, Peru.
The potential for small-scale farmers to access national and regional markets for fresh and frozen potato chips in Burundi, Ethiopia, Kenya, Rwanda Tanzania and Uganda

B. Lemaga, J. Nsumba, A. Bombom, A. Tesfaye, G. Okoboi and G. Thiele

Demand for potato chips has been increasing in the eastern and central African (ECA) countries, but there is considerable lack of information on the potential of fresh and frozen potato products in the regional market. This study was carried out in six ECA countries: Burundi, Ethiopia, Kenya, Rwanda, Tanzania and Uganda from 2004 to 2006. Two to three cities or towns in each of the six countries were selected for the study based on the extent of either consumption or production of potatoes. A sampling strategy selected respondents from the different cities and clustered them into three homogenous groups. The groups were hotels, bars and restaurants, and household consumers. In addition, information was collated from supermarkets and local processors. Data were collected from primary and secondary sources.

Despite increasing demand for processed potato products, especially chips, processing enterprise is either absent or at a very early stage. Only Kenya has a factory that processes and sells frozen chips to the niche markets. Three market channels were also found from which fresh and processed potato can be sourced; these are the retail stores, processors and consumers. Anyone of these in the market chain may be a processor or consumer along the chain. However, the lack of a sustainable supply of chips to match the demand in the region forced some hotels, restaurants and supermarkets to import frozen chips from either Europe or South Africa. Nonetheless, the potential to produce high quality potatoes suitable for making quality chips is available within the ECA. Moreover, the availability of credit facilities, the COMESA trade agreement and the growing demand for processed chips offer a great opportunity for a very profitable processing industry in the region. This has great potential for small-scale producers to access the chip market at both national and regional levels, leading to increased household incomes, reduced poverty and improved livelihoods.

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Fighting poverty in Ecuador through potatoes: the FORTIPAPA experience

I. Reinoso

The National Agricultural Research Institute of Ecuador (INIAP) implemented a project to develop a new institutional framework to improve the quality of life of limited-resource farmers by linking them with markets. This project, called FORTIPAPA-IV Phase, operated from 2003-2007 funded by the Swiss Agency for Development and Cooperation (SDC) and received strategic support from the International Potato Center (CIP), through the Papa Andina Initiative. Two approaches were followed: first, to create multi-stakeholder platforms to coordinate actions and build trust among partners, including INIAP, universities, local governments, and non-governmental organizations; and second, to identify niche markets to guide the potato production. FORTIPAPA-IV contributed to: (i) strengthening farmers’ organization; (ii) bringing together farmers’ organizations, research organizations and other service providers through the stakeholder platforms; (iii) developing a potato-based business to add value for limited-resource farmers; and (iv) developing a demand-led potato seed system.

Nearly 40 partners coordinated actions through the platforms and as result the Consortium of Low-Resource Potato Producers (CONPAPA) was created, including over 1500 families as direct beneficiaries. These farmers grow an improved potato cultivar (INIAP-Fripapa) which has good processing characteristics and requires less fungicide to protect against late blight than alternatives. Their production is sold to local restaurants, obtaining an increase of 21% in total income. Intensive training and good-quality seed led to a dramatic yield increase: the average yield of CONPAPA farmers (17.5 t ha\(^{-1}\)) was nearly 70% above than the national average (10.4 t ha\(^{-1}\)). The future is also encouraging, since SDC is funding a Phase V of FORTIPAPA to consolidate CONPAPA.

FORTIPAPA - ECUADOR
The climate as a factor in determining the profitability of the potato crop in five areas of the Peruvian coast and sierra

H. Venero and V. Alva

The study aimed to analyze the effect of climatic phenomena on the profitability of potatoes to small producers in five areas of the coast and sierra of the country. We did a statistical and econometric analysis (OLS) of the variables that determine profit, based on cost structure and revenue, considering invisible costs such as like family labor. It is also estimated the equilibrium price and its relation to the levels of production and the market price.

The main hypothesis of the study is that climate is a major factor (but not the only one) that affects production levels and profits earned by small potato farmers, but not equally. The consequences depend on factors such as the type of climatic event (frost, drought, heavy rains), the location of the plot, the date of planting, elevation and slope of the plot, and so on.

To test this hypothesis we used a sample of small potato farmers distributed in the valleys of Chancay-Huaral, Supe-Pativilca and Fortaleza, and Tambo in the Peruvian coast, and Acocro and Panao in the Peruvian sierra. We used the Profitability Survey of the Ministry of Agriculture, which surveyed more than 260 households between 2004 and 2006. The sites that are the focus of the analysis are some of the main centres of potato production in the country. Those areas are also strongly linked to major markets on the coast, the capital Lima in particular. However, it was surprising to find that these small producers are highly dependent on income from the agricultural sector (which involves high risk, in particular the case of the potato crop), and present high levels of poverty. Hence the major questions that were answered in this research are as follows. How important is the climate factor in determining the profitability of potato crop? Could it be determined with certainty whether the climate factor is more important than the proper application of inputs into this crop? Why is it that, despite the uncertainty with respect to the climate (and poor information about these phenomena), farmers prefer to sow potato?

Ministerio de Agricultura, IEP, Perú.
Native potato farmers’ access to high value markets

A. Gandarillas, S. Arandia and J. Blajos

A greatest diversity of native potatoes in Bolivia is concentrated in zones known as microcenters, in which, paradoxically, farmers are unable to obtain economic advantages from the biodiversity and where risk of genetic erosion exists.

In this paper, we describe the experience acquired from the Municipality of Colomi (Cochabamba-Bolivia), an important biodiversity microcenter, where the implementation of a strategy in conservation and biodiversity use, promoted by the PROINPA Foundation and Papa Andina Project, has allowed conservationist farmers access to high value markets. This work was carried out with a participatory approach, with different food-chain actors, producers, agro-industrial concerns and supermarkets. This participation allowed the generation of important technological, commercial and institutional innovations.

More than 60 native potato varieties were identified and the production systems were improved, as well as the processing and marketing. The technology was developed by a Local Agricultural Research Committee (CIAL). Two commercial products, chipas and brightly colored chips of were identified and commercialized in supermarkets with a brand name. The CIAL evolved into a Producer Association (APROTAC). Producers, together with traders and industrialists, selected five varieties due mainly to their commercial and transformation potential.

Nine commercial channels have been opened to supermarkets and agri-business, the quantity of seed grown by farmer has increased from 40 to 600 kg. The commercial volumes have increased from 330 kg to 1680 kg/per year/farmer. Sell prices have increased from Bs. 0.55/kg to Bs.2.38/kg.

APROTAC is an association well positioned and sustainable, its experience has been replicated to other microcenters of biodiversity (Morochata, Llallagua, Kariquina, Sora Sora), working with different native potato varieties and commercial channels, besides other products like gourmet potatoes, whose consumption has been increased in our country and with the intention to export them to Europe.

Fundación PROINPA, Bolivia.
Environmental pressures on the potato supply chain in the United Kingdom

D.G. Nelson

Potato growing in the United Kingdom has needed to conform to a wide range of environmental pressures and constraints over recent years. These pressures include limitations on use of pesticides, countryside management, water and soils protection and most recently, issues relating to carbon footprint. These issues will be discussed giving examples of how agronomic decisions can aid compliance with sustainable farming objectives. For example, the role of variety choice, field boundary management, cultivations and fertiliser application method. The wider implications of such pressures on productivity and food supply are considered for both urbanised and developing societies are considered.

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Numbers and titles of poster presentations

Session 1

1.1 Innovation in seed potato production for developing countries using aeroponics
V. Otazú, I. Barker and E. Chujoy

1.2 Identification of putative somaclones by means of SSR marker analyses of a large collection of South American potatoes
M. Ghislain, J. Núñez, D. Spooner and J.C. Glaszmann

1.3 Potato defense to biotic stress: identification and characterization of differentially regulated genes
A. Arruabarrena, A. Correa, C. Gaggero, I. Ponce de León and M. Montesano

1.4 Diploid potato breeding in Colombia
L. Rodríguez, C. Núñez and S. Navía

1.5 Two new potato varieties (Solanum tuberosum ssp. andigena with horizontal resistance to late blight selected by Andean communities through participatory varietal selection
J. A. Landeo, M.A. Gastelo, M.A. Pacheco, S.D. Haan, L. Diaz, E. Puente and C.C. Challabamba

1.6 Resistance to Phytophthora infestans in the Colombian collection of the Phureja group
C.E. Núñez L., S. Tinjacá R. and J.M. Cotes T

1.7 The potential of plant growth promoting bacteria (PGPR) to improve potato tuber yields and tuber quality
A. Oswald, P. Calvo and D. Zuñiga

1.8 Climatic changes and potato crop production in the central part of Romania
Gh. Olteanu, C. Aldea, M. Buiuc, C. Olteanu and L. Asanache

1.9 Phosphites in disease management, yield and tuber quality – enhancing sustainability of potato production
A.B. Andreu, D.O Caldz and G.A. Forbes

Session 2

2.1 Ecuadorian native potatoes - an invaluable gene resource
J. Rivadeneira

2.2 Irish potato production and challenges in a rural area: the case of Fokoue, West Cameroon
J.C. Mbomeda, A. Tchoumba and S.C Teke

2.3 Participatory evaluation of selected components of integrated control of potato late blight in central Kenya
M. Nyongesa, P. Gildermacher, C. Lung’aho and G. Forbes

2.4 Participative evaluation of field resistance to powdery scab (Spongospora subterranea) and potato cyst nematode (Globodera pallida) in two highland communities of Junín and Huancavelica in Peru
R. Ccanto, R. Gómez, E. Olivera, J. Poma and M. Scurrah
2.5 Farmer participatory research to optimize the yield of large-sized, market-preferred French fry processing Solanum potato tubers in Kabale district, Uganda

2.6 Tillage erosion within intensively cultivated Andisols in Costa Rica
K.H.D Tiessen, F. Sancho, D.A. Lobb and G. Mehuys

2.7 Tillage translocation and tillage erosion within intensive potato production systems in Atlantic Canada
K.H.D. Tiessen, G.R. Mehuys, D.A. Lobb and H.W. Rees

2.8 Traditional soil conservation and land preparation technologies unique for potato production in the central Andean highlands
A. Oswald, S. de Haan, J. Sanchez and R. Ccanto

2.9 The Abundance Farming Project in affiliation with Absorbent Technologies Inc. provides the first bio-degradable super-absorbent starch-based soil amendment to benefit poor potato farmers
P.A. Osterlund

Session 4

4.1 Role of potatoes in the diet of children and women of highland rural communities of Huancavelica
G. Burgos, R. Liria, H. Creed-Kanashiro, S. De Haan and M. Bonierbale

4.2 PAPASALUD - An international project to exploit the potential of native potato species for sustainable agriculture

4.3 Innovating with socially responsible enterprises for sustainable marketing of potato biodiversity by small-scale farmers in Peru
A. Thomann, A. Devaux, M. Ordinola and T. Bernet

4.4 The potato seed keepers in Peru
M. Tapia