



The role of potato in rural development and food security

Experiences from the Andes, West Africa and China



Une asbl de la Province de Hainaut

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About CARAH

- Center for Agronomy and Agro-Industry of Hainaut Province, Belgium
- Field/lab research and extension
- Services for agri-food sector

Potato production is a pilar of Hainaut agriculture – 21 000 ha



Important presence of processing industry





International agronomy projects

- Focused on potato
 - Late blight warning system
 - Disease and pest IPM control
 - Certification Seed production
 - Fertilization
- Expertise and training
 - China Bangladesh Vietnam Kazakhstan
 - RD Congo Mali Guinea Rwanda - South Africa







 Development of a late blight warning system in China 1700 weather stations







+ pilot projects in Guinea, Rwanda, Bangladesh and Vietnam #InternationalDayofPOTATO





 Training the inspectors of the future seed certification body in Kazakhstan







 Creating a fertilization advice software for potato farmers in Mali and training technicians to use it









 Organizing training/study tours in Belgium and Europe for young farmers, researchers or technicians.



MINISTRY OF AGRICULTURE AND RURAL AFFAIRS OF THE PEOPLE'S REPUBLIC OF CHINA

Potato: a global crop

- Grown in over 150 countries, potato is the third most consumed food crop globally.
- It is an adaptable crop with high-yielding capacity and significant potential in low-income rural areas.

From the Andes to Africa: how potato supports rural communities

- In many regions, potato plays a critical role in:
 - Providing short-cycle income for smallholders
 - Enhancing food self-sufficiency
 - Contributing to nutrition security
 - Creating potential for market access and local entrepreneurship
- Today's speakers will share practical experiences from:
 - the Andes
 - West Africa
 - Rural China

About today's speakers

André Devaux

André Devaux is a Belgian agronomist with over 35 years of experience in research for development. His career has been largely associated with the International Potato Center (CIP), where he held various positions in East Africa, Pakistan and the Andes, including Regional Director for Latin America. He coordinated CIP's programs in the Andes and contributed significantly to the promotion of native potato diversity and smallholder competitiveness in the Andes. He is Director on the World Potato Congress Board.

About today's speakers

Bruno Vanderhofstadt

Bruno Vanderhofstadt is a field agronomist who has dedicated his entire career to developing potato-based projects across Africa. He is the author of two landmark technical manuals on potato cultivation: one focused on West Africa and the other on the Democratic Republic of Congo (DRC). His work has contributed to the expansion of potato farming from a luxury product to a key food crop in multiple African regions.

About today's speakers

François Serneels

François Serneels is an agronomist who led international cooperation projects at CARAH, particularly in China and other Asian countries. His expertise on potato systems and disease warning networks has been widely recognized. He was honored by the Chinese government as one of the 40 most influential foreign experts since China's opening and received the prestigious "Friendship Award," the highest distinction granted to a foreign expert in the country.

- A Q&A session will follow the presentations. Please use the dedicated Q&A feature in Teams to submit your questions.
- Une session de questions-réponses suivra les présentations. Veuillez utiliser la fonctionnalité dédiée dans Teams pour poser vos questions.
- Después de las presentaciones habrá una sesión de preguntas y respuestas. Por favor, utilice la función dedicada en Teams para enviar sus preguntas.

The role of potato biodiversity in food security and competitiveness of small-scale producers: lessons from the Andes

André Devaux¹ and Miguel Ordinola²

¹Member of the World Potato Congress' Board of Directors ¹Scientist Emeritus, International Potato Center (CIP) ²Adviser, International Potato Center (CIP)

I. Introduction: The Andes and potato biodiversity

- II. Market opportunities based on potato biodiversity
- III. Biofortied potatoes to reduce chronic malnutrition
- IV. Transition from the Andes to the West Africa and China

I. The Andes, the home of cultivated potatoes

• Huge genetic variation at the center of origin and still 4,000 native potato varieties grown in the Andes today

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Conservation y use of potato genetic resources :	
CIP germplasm bank	
Category	<u>Total</u>
Cultivated/ native potatoes	
Species	7
Accessions	4894
Wild potatoes	
Species	145
Accessions	2596
Improved clones from breeding	1610
Species	152
Accessions	9100

Source, Vania Azevedo, CIP (2022)

Province de Hainaut

- 3,300 4,200 m.a.s.l: extreme climate
- Predominance of small-scale farmers (1 to 5 ha), weakly organized
- Cultivated by around 1,000,000 Andean families
- "Potato-based" livelihood system, dual purpose (food crop and source of income)
- Low potato productivity (8-10t / ha)
- High vulnerability context (climate change)

⇒ High production risks, limited services and difficulty accessing urban markets

II. ANDEAN SMALL-SCALE FARMERS MARKET OPPORTUNITIES

Mainly rural markets with low added value.

- Challenge: How to enhance smallscale farmers access to high value markets and improve incomes?
- Opportunity: How to take advantage of the rich, nutritious and colorful potato biodiversity?

The challenge: how to link small-scale Andean potato producers to high value markets

STIMULATING INNOVATION ALONG VALUE CHAINS

Andean farmer's asset: Potato biodiversity

Research outputs:

Creative ideas,
technologies, methodologies

Interaction with different stakeholders

Dynamic Markets

New products with added value

Partnership, new working relations

Capacity to innovate

PARTICIPATORY MARKET CHAIN APPROACH

(PMCA)

#InternationalDa

COMMERCIAL INNOVATION: better differentiation in native potato marketing

Research needs

- Selection of native potatoes for processing
- Processing protocols and prototype products
- Crop management, healthy seed production

CIP role in new product development triggered by the PMCA, Peru. Source: Devaux et al. 2020

COLORED POTATO CHIPS: product development and creative imitation

Sales and Price of native potatoes have increased in Peru

Survey carried out in 2021:

Native potato snacks represent 23% of consumer preferences in Lima, important development of this market which was almost inexistant in 2008. 1US\$= 3,6 Peruvian Sol

Source: Data from National Survey of Rural Households-Income of Agricultural #InternationalDayofPOTATO Producers. MIDAGRI 2010-2021.

Phases 2-3: Ecuador, Knowledge sharing, creative imitation.

KIWA: colored potato chips mainly for export

ofPOTATO

Native potato chips included in Ecuador **SuperFoods Cluster** to promote export (2023)

Key elements to promote potato biodiversity in competitive markets for producers' income generation, competitiveness and food security.

- Strengthen the capacity of producer organizations to participate in markets.
 Keys: Youth and entrepreneurship.
- Reduce production costs, increase productivity, and <u>enhance adaptability</u> in the face of climate change for food <u>security</u>
- Promote policies and services that respond to the needs of small-scale farmers (capacity building, access to information and technologies, business skills, credit, insurance)

III. BIOFORTIFIED POTATOES WITH Fe TO REDUCE CHRONIC MALNUTRITION

- Incidence of anemia affects nearly 40% of the population in the high Andes
- CIP is implementing a selection program of new varieties and characterization of native potatoes with:
 - Higher concentration of micronutrients (Fe))
 - Higher productivity & resistance to pests and diseases for more sustainable production
- It is key to promote biofortified varieties with nutritional education and through social protection programs

Biofortified potatoes with Fe: a solution?

- Potato biodiversity with its genetic variability of Fe content is used to obtain varieties richer in Fe
- Potatoes contain low levels of iron compared to grains and vegetables, but have:
 - low levels of phytates, an inhibitor of iron absorption.
 - high levels of vitamin C, which promote iron absorption.
- Iron content is not affected by boiling

In rural Andean areas, the potato is the main component of the diet, and its consumption varies between 300 and 800 g per day for adults.

Biofortified potatoes in rural Andean areas, an alternative

Improved and native biofortified potato varieties have on average a 50% higher Fe content than commercial varieties.

Consumption of 500g of iron-fortified potatoes:

 could provide 50% of the Fe required in women living in these areas with moderate iron reserves in the blood (ferritin level around 10 µg/L)

Source: Burgos et al. 2023 <u>https://doi.org/10.1016/j.tjnut.2023.04.010</u> #InternationalDayofPOTATO

Biofortification of potatoes with iron by conventional genetic selection is a promising approach to improve iron intake in anemic women in rural Andean areas that can be applied in other regions.

IV. Transition from the Andes to West Africa and China

The potato's odyssey around the world, a fantastic journey!

- Potatoes are currently cultivated on about 20 million hectares worldwide under different agroecological conditions
- Potato is the third most important nutritive crop worldwide after rice and wheat

Thank you!

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Strengthening the potato value chain to increase farmers' income and improve food security in West Africa





Bruno Vanderhofstadt, Mahamadou Coulibaly, Bourema Goïta BelHOr mai 2025





The plant needs a period of cold to tuberize





Africa over view



Potato production (t) by subregion in Africa







Potato production system in Mali







Mali Seed tubers

- Origine : Europe from class A, Maghreb non certified
- Varieties : Early varieties, white skin, yellow flesh, big size tubers
- Price : 1.100 F cfa/kg = 1,67 euro/kg
- Germination :
- Tuber cutting :
 = 500 à 800 Kg/ha







ubers on the al bud end up



Mali Crop management

- Fertilisation : use of NPK fertilizer for cereals (15-15-15) often in excess and with little use of organic fertiliser
 Sail properties :
- Soil preparation :





Pockets 30 x 30 cm

Ridges 50 to 75 cm



• IRRIGATION :

Mali Crop management



Traditional method

Improved method





Mali Diseases and pests

- BACTERIA :
- Ralstonia solanacearum (Pseudomonas solanacearum)
 - Pectobacterium atrosepticum Pectobacterium carotovorum Dickeya spp. (Erwinia)







• Common scab (Streptomycesspp.) : occasional



Mali Diseases and pests

- FUNGI :
- Late blight (Phytophthora infestans) : In dry season, climatic conditions do not allow development of late blight.
- Early blight (Alternaria solani / alternata) : rare
- Dry rots (Fusarium) and Gangrene (Phoma exigua) : during storage
- Balck scurf (Rhizoctonia solani) : occasional
- PESTS :
- *Tuber moth :* very rare in Mali
- Nematodes (Meloïdogines and Globodera) : to monitor



Pesticides are rarely used in potato production in Mali The exceptional case of the Sikasso region is worth mentioning, where potatoes are grown primarily in lowland areas. Since these areas are flooded during the rainy season, a large number of pathogens and/or parasites are destroyed. Potatoes have been grown there every year for over 40 years.



Mali Crops and cost production

• CROPS :

- Production cycle : +- 3 months
- Harvest : manual
- Yield between 20 to 33 t/ha Sikasso region average 22 t/ha
- COST PRODUCTION
 - 2.500.000 Fcfa/ha = 3.810 euro
 - Estimated gross price par Kg : 114 F CFA = 0,17 euro

Distribution of the estimated cost of 1 ha potato production ; total of 2.5 millions F cfa = 3810 euro







WHOLE SALE MARKET PRICE :



Big size

Minimum price : Big size : 250 F CFA/kg 0,38 euro/kg Small size : 100 F CFA/kg 0,15 euro/kg

Mali **Market and** conservation

- **Conservation:**
 - Traditional box : April to june 30 F CFA/Kg = 0,045 euro/kg
 - Cold storage : < 5 % of production April to August 60 F CFA/kg/ 5 months = 0,09 euro/kg









Potatoes in West Africa are a typical cash crop. They can generate incomes, but they require investement and therefore also involve risks.



Change in consumption habits and geographical crop dispersion

Mali Food security



- Production between 350.000 and 400.000 t in Mali (estimation 2024-25)
- Income generation through a sector turn over of minimum 70 millions euro/year
- Cash crop : self consumption <5 % (small sizes and damaged)
- Cash inflows starts on the begining of the food shortage period



Mali and West Africa

Challenges

To bring larger quantities of potatoes to market responding to demand while maintaining an affordable price for the consumer and attractive profits for the producer

• Sustainability of production :

- Increased average yields and preservation of quality
- Continuity of producer organizations
- Rational fertilization wih more organic matter and crop rotation
- *Ralstonia solanacearum* management (seeds, soil and water)
- Market :
 - Expansion and diversitication of production areas
 - Development of storage capacities
 - Increase in exports to coastal countries
- Local multiplication of hight quality seed tubers :
 - Local production of seed tubers is technically feasible and profitable
 - Strengthening of seed multipliers
 - Continued implementation of the specific certification scheme
- Climate change :
 - Water management: irrigated land on perimeter supplied by solar-powered pumping systems
 - Development of early-maturing crops



Potato in China: from staple food for vulnerable populations to a driver of poverty alleviation



François SERNEELS, Xingbi CHE, webinar for CARAH, Ath, Belgium 21/05/2025





Introduced in the 17th century

Generalized in W, SW, N at the end of 19th century

Almost no attention by authorities until 1990s

Consumed as vegetable, snack or raw material (noodles)





Potato consumption :

- 47 kg/year.person
 - regional food : North, SW
 - arid + mountainous
 - poor people's food (× rice, noodles)



 « How the Chinese eat potatoes »
 2008: International Year of the Potato by Qu Dongyu (today FAO DG) and Xie Kaiyun (CIP Beijing)





Stapleisation » : potato becomes the 4th staple crop in 2015-16

Initially 3 staple food = grains : rice, wheat, corn

National policies for research, monitoring of production, price control, distribution in case of local food scarcity, investments in infrastructures

But their yields are already quite good => increase is not easy



- Potato :
- Actual average yield (10-15t/ha), low compared to potential (40)
- Good nutritional content
- Agronomic advantages : drought and cold resistance, adaptability
- Profit 400-600 Rmb/Mu (6000 Rmb/ha = 770€/ha) compared to
 less than 200 for grains (average income of Chinese farmer in 2022 : 20 000 Rmb/year)



Example 1 : Chongqing

- Monsoon humid subtropical climate
- Slopy micro-fields in moutainous landscape
- Manual labour, very small farm (<0,5ha)
- Intercropping with corn or vegetables
- often no rotation !! (many years with only potato)











Example 2 : Gansu

- Arid continental climate : 300 mm/year Irrigation, plastic mulching, adapted varieties
- Loess plateau : 1500 m altitude
- Partly mechanized family labour, small farm (1ha)









Example 3 : Inner Mongolia

- 4 months cropping season,
- Rainfall 430 mm/year (in summer)
- Pionneer mechanized agriculture
- Small to very big farms (>500ha)
- Perfect for seed potatoes







Competitiveness : mechanization, small mechanization ! Ploughing,

planting, hilling, uplifting/harvesting



Competitiveness : mechanization, small mechanization and « high tech » mechanization!

- Pivot Irrigation
- Travelling gun
- Plastic mulching + drip irrigation









Competitiveness : mechanization, small mechanization and « high tech » mechanization!

- Wide tractor-pulled sprayer
- Thermic or electrical back-pack sprayer
- Drone sprayer







Competitiveness : lateblight

- Traditional curative spraying : too late, unappropriate or low quality fungicide
- Warning systems : HSJD-Carah in 14 provinces, HEBAU in Hebei and NE provinces
- Interest of widely shared unified system + training
- Next step : biofungicides







Competitiveness :varieties

- Old Western varieties highly degraded (non pure, virus-infected)
- Intensive local selection programmes in many provinces
- New varieties provided by CIP for crossing
- Western industrial varieties







Competitiveness : seed potatoes multiplication

- Traditional planting of non seed potatoes \rightarrow large distribution of highly virus infected seed potatoes
- Cut tubers treated with ashes or other desinfecting/drying powder
- Absence of seed potato certification
- + Strong development of private sector with local government support : 300 companies
- + Claim that 50 % area planted with virus free seed tubers

- Threat of cyst nematods (many areas with short or no rotation!) : *Globodera r.* and *p.* detected in Yunnan and Sichuan in 2022. https://doi.org/10.1094/PDIS-06-21-1263-PDN





Competitiveness : fertilization

- Increase in fertilizers inefficient use >300 % in 30 years increase in grain 60 %
- Balanced/unbalanced fertilization
- Important role of K in tuberization

PEPE BE



(高浓度硫酸钾复合肥)						A
氮磷钾	ExpectedGlobal needs of the cultureyield(kg/mu)					
13-17-15		Ν	P2O5	K2O	MgO	¢
tobal it	2,7 t/mu	13,3	4,0	16,0	1,3	and the second
海会量:50kg	3,2 t/mu	16,0	5,0	19,3	1,7	
GB15063-2009 (鲁) XK13-001-00005	3,7 t/mu	18,3	6,0	22,0	2,0	



Competitiveness : soil acidity

Effect of pH : example of Wuxi

- pH 4,7
- Liming 100kg/mu (1500kg/ha)
 => +20 % yield





Wuxi pH interpolation map according to the result of 200 soil analyses in 2018



Map of pH of soils of China (source: Chen et al.)





Processing and new products

- Starch : 600 000 t => noodles 300 000 t
- Food ingredients regulation : potato starch mixed with other flours for pastries, cakes and bread
- Marketing on specific issues:

Geographic origin (Wuxi, Chongqing)



Selenium rich (Enshi, Hubei)







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Processing and new products

- Natural potato chips : 390 000 t
- Compound potato chips : 370 000 t
- Frozen fries : 300 000 t
- International competition / local markets





Role of public services to support small farmers

- Example : potato late blight warning system
- Strategies of local authorities to develop the production at the scale of one or several districts/counties with priority to poorest ones
- Lack of coordination between services





Problems :

- over-fertilization : water pollution
- soil degradation : reduced production
- pollution by pesticides
- workers'exposure to pesticides
- pathogens'resistance to pesticides
- resource scarcity (mineral fetilizers, energy, ...
- climate change






Sustainability of PSF « Potato Staple Food »-Policy

« Integrating potato as a staple in China and close the yield gap has the potential to reduce the total carbon–land–water impacts of staple crops by 17–25% by 2030. »



Fig. 3 | Cropland use, GHG emissions and water use under various scenarios. **a**, Total land use in 2015 and land savings under various scenarios in 2020-2030. **b**, Total GHG emissions in 2015 and GHG reduction under various scenarios in 2020-2030. **c**, Total water use in 2015 and water savings under various scenarios in 2020-2030. Error bars denote base cases \pm s.d. S0 denotes the baseline scenario, S1 the PSF-policy scenario and S2 the strategic potato-siting scenario. Note that each scenario is contingent upon the previous one. Total land area projected in 2030 is below China's red-line capacity (that is, 1.24×10^5 kha "red line", which is defined as the area of arable land needed to ensure China's food security), and there is also enough capacity for cropland expansion at the provincial level (Supplementary Table 1).

#InternationalDayofPOTATO Beibei Liu, 2021 https://doi.org/10.1038/s43016-021-00337-2



Conditions of sustainability of PSF-policy

(1) promote the nutritional value of potato among Chinese households

(2) encourage food industries to produce potato substitutes for wheat products (for example, potato noodles and flour)

(3) further enhance the competitiveness of potato against other staple foods by facilitating research and development to breed new high-yield varieties with optimized local performances, thereby reducing the transport and storage costs of potato

(4) Coordinate food security and environmental sustainability policies





Key lessons

High potential of potato development in many regions (not all)
Major role of consistent policies
Importance of research but also extension

3. Importance of research but also extension





Conclusions







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The potato, an effective solution to meet global challenges

Resilience

- High yield capacity,
- Adaptability to different agroecological systems
- A relatively short growing cycle compared to other crops
- Carbon footprint



Subsistance and income

- **Dual role** in the economy of family farming as a **cash crop** and/or **food** for domestic consumption
- **Produced locally**, can play an important role in food crises
- Demand for processed potatoes increases in the South, providing added value

Energy and nutrition

- Nutritious and energy-rich, potatoes are an excellent source of vitamin C, potassium and dietary fiber.
- They also contain **micronutrients** such as Fe and Zn



Specific challenges

Agronomic sustainability

- Overuse/misuse of farm inputs
- Limited crop rotation
- Soil degradation
- Water management
- Disease management
- Limited access to clean, certified seed potatoes

Climate change

 Increased effects on potatobased systems

Post harvest and market

constraints

- Storage infrastructure
- Limited market access for small producers
- Lack of visibility for native and local varieties

Need for :

- Coordinated public support
- Research
- Extension and access to services
- Market incentives
- Public-private partnerships



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