



Potatoes, nutrition and diet

Potatoes can be important staple foods, but balanced diets need to include other vegetables and whole grain foods

Key Points

The potato is a good source of dietary energy and some micronutrients, and its protein content is very high in comparison with other roots and tubers.

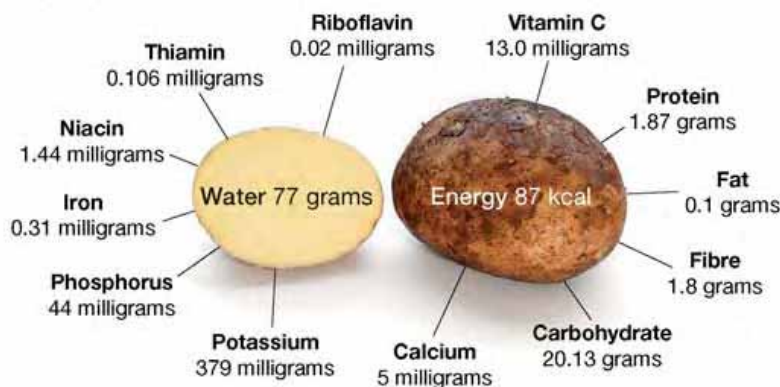
Potato is low in fat – but preparing and serving potatoes with high fat ingredients raises the caloric value of the dish.

Boiling potatoes in their skins prevents loss of nutrients.

Potatoes are important in many diets, but need to be balanced with other vegetables and whole grain foods.

Further research is needed to determine the link between potato consumption and Type 2 diabetes.

Nutrient content of potatoes



(Per 100 g, after boiling in skin and peeling before consumption)

Source: United States Department of Agriculture, National Nutrient Database

Potato is a versatile, carbohydrate-rich food highly popular worldwide and prepared and served in a variety of ways. Freshly harvested, it contains about 80 percent water and 20 percent dry matter. About 60 to 80 percent of the dry matter is starch. On a dry weight basis, the protein content of potato is similar to that of cereals and is very high in comparison with other roots and tubers. In addition, the potato is low in fat.

Potatoes are rich in several micronutrients, especially vitamin C – eaten with its skin, a single medium-sized potato of 150 g provides nearly half the daily adult requirement (100 mg). The potato is a moderate source of iron, and its high vitamin C content promotes iron absorption. It is a good source of vitamins B1, B3 and B6 and minerals such as potassium, phosphorus and magnesium, and contains folate, pantothenic acid and riboflavin. Potatoes also contain dietary antioxidants, which may play a part in preventing diseases related to ageing, and dietary fibre, which benefits health.

Effects of potato preparation methods

The nutritive value of a meal containing potato depends on other components

served with them and on the method of preparation. By itself, potato is not fattening (and the feeling of satiety that comes from eating potato can actually help people to control their weight). However, preparing and serving potatoes with high-fat ingredients raises the caloric value of the dish.

Since the starch in raw potato cannot be digested by humans, they are prepared for consumption by boiling (with or without the skin), baking or frying. Each preparation method affects potato composition in a different way, but all reduce fibre and protein content, due to leaching into cooking water and oil, destruction by heat treatment or chemical changes such as oxidation.

Boiling – the most common method of potato preparation worldwide – causes a significant loss of vitamin C, especially in peeled potatoes. For french fries and chips, frying for a short time in hot oil (140 °C to 180 °C) results in high absorption of fat and significantly reduces mineral and ascorbic acid content. In general, baking causes slightly higher losses of vitamin C than boiling, due to the higher oven temperatures, but losses of other vitamins and minerals during baking are lower.

Potato's role in the developing world's "nutrition transition"

In many developing countries, and especially in urban areas, rising levels of income are driving a "nutrition transition" toward more energy-dense foods and prepared food products. As part of that transition, demand for potato is increasing. In South Africa, potato consumption has been growing in urban areas, while in rural areas maize is still the staple. In China, higher income and increased urbanization have led

to increased demand for processed potatoes. Thus, the potato already plays a role in diet diversification in many countries. However, where other staple crops are available to meet energy requirements, potato should not replace them but rather supplement the diet with its vitamins and mineral content and high quality protein. Potatoes can be important staple foods, but balanced diets need to include other vegetables and whole grain foods.

As part of the trend toward greater consumption of "convenience foods", demand for fried potatoes is increasing. Over-consumption of these high-energy products, along with reduced physical activity, can lead to overweight. Therefore the role of fried potato products in the diet must be taken into consideration in efforts to prevent overweight and diet related non-communicable diseases, including heart disease and diabetes. Type 2 diabetes is caused by many factors, and further research is needed to determine whether potato consumption and Type 2 diabetes may be linked.



Toxic components of potato

As part of the potato plant's natural defences against fungi and insects, its leaves, stems and sprouts contain high levels of toxic compounds called glycoalkaloids (usually solanine and chaconine). Glycoalkaloids are normally found at low levels in the tuber, and occur in the greatest concentrations just beneath the skin.

Potatoes should be stored in a dark, cool place in order to keep glycoalkaloid content low. Under exposure to light, potatoes turn green in colour due to increased levels of chlorophyll, which can also indicate higher levels of solanine and chaconine. Since glycoalkaloids are not destroyed by cooking, cutting away green areas and peeling potatoes before cooking ensures healthy eating.

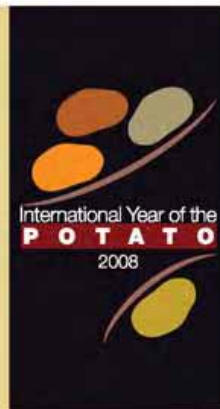
About IYP 2008

The **International Year of the Potato**, to be celebrated throughout 2008, aims at raising global awareness of the potato's key role in agriculture, the economy and world food security.

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Potato and biodiversity

By conserving – and utilizing – the potato genetic diversity developed by their ancestors, small farmers in the Andes are helping ensure world food security



Key points

Potato farming systems need a continuous supply of new varieties drawn from the entire potato gene pool.

Potato biodiversity is under threat – ancient varieties cultivated for millennia have been lost and wild species are threatened by climate changes.

Smallholder farming systems in the Andes encourage cross-pollination of potato flowers, vital to sustaining the diversity of local, farmer-developed varieties.

With CIP support, Andean communities have created a "potato park" holding some 1 200 traditional varieties of potato.

The history of the potato provides a grim warning of the need to maintain genetic diversity in our staple food crops. In the 19th century, Ireland was heavily reliant on only a few varieties of potato, and those types contained no resistance to the devastating disease known as late blight. When late blight destroyed the 1845-1846 potato crop, widespread famine followed. An estimated one million people starved to death and more than a million were forced to migrate abroad.

To combat pests and diseases, increase yields, and sustain production on marginal lands, today's potato-based agricultural systems need a continuous supply of new varieties. That requires access to the entire potato gene pool. But potato biodiversity is under threat: ancient varieties cultivated by Andean peoples for millennia have been lost to diseases, climate change and social upheaval.

Species and crop-associated diversity

While most varieties of potatoes belong to a single species, *Solanum tuberosum*, about 10 other *Solanum* species have been cultivated, and 200 wild species have been recorded. Climate change may threaten the survival of those wild relatives: it is forecast that as many as 12 percent will become extinct as their growing conditions deteriorate. If climate



Farmers sort varieties at Peru's "potato park". Photo: © CIP

Centre of origin

In the Andean region, generations of farmers have domesticated thousands of potato varieties. Even today, farmers cultivate up to 50 varieties on their farms. In the biodiversity reserve of the Chiloé archipelago in Chile, local people cultivate about 200 varieties of native potato. They use farming practices transmitted orally by generations of mainly women farmers.

changes drastically, the area where wild potatoes grow naturally could be reduced by as much as 70 percent.

Since potatoes mostly propagate vegetatively, most commercial varieties of potato have a reduced ability to flower and breeders do not select for traits that make the flower attractive to pollinators. However, natural potato pollination remains important to sustaining the diversity of land races (farmer-developed varieties that are adapted to local environmental conditions). Fortunately, the diverse smallholder farming systems in the Andes harbour a variety of flowering plants that do attract pollinators, such as honeybees and bumblebees, which promote cross-pollination of potato flowers, thus increasing seed production and sustaining diversity.

International Treaty

The potato is included in the multilateral system established under FAO's International Treaty on Plant Genetic Resources for Food and Agriculture.

The Treaty, which entered into force in 2004, aims at the conservation and sustainable use of crop plant diversity and the fair and equitable sharing of benefits derived from their use.

Conserving potato biodiversity in the Andes

Having lost many of their traditional potato varieties, Peruvian farmers in the Andes are now taking measures to conserve and sustainably use those that remain. A pact has been signed by six Quechua communities with the International Potato Center that recognizes the rights of the communities over potato strains they have developed.

Under the agreement, the Center's genebank returns potato genetic resources – and knowledge associated with them – to the communities, which have established a "potato park" (*Parque de la papa*) in a conservation area where they grow and manage the plants. This repatriation of biological diversity effectively keeps control of genetic resources local. The 15 000 ha park is a "living library" of potato genetic diversity, holding some 1 200 varieties of potato cultivated in the highlands. A long-term goal is to re-establish all the world's 4 000 known potato varieties in the valley, allowing the park to function as a second centre of origin for this vital staple crop.



Inside CIP's gene bank. Photo: © CIP

Diversity conserved in trust

The International Potato Centre in Peru maintains the world's largest bank of potato germplasm, including some 1 500 samples of about 100 wild species collected in eight Latin American countries, and 3 800 traditional Andean cultivated potatoes. The collection is maintained and managed under the terms of an agreement with the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture and, like all collections eligible for funding from the Global Crop Diversity Trust, is available to plant breeders worldwide upon request.

Credits:

Information provided by the Global Crop Diversity Trust and the Plant Production and Protection Division, FAO.

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Potato and gender

Around the world, rural women are essential to conservation, seed selection, planting, harvesting, storing and marketing of potatoes



Key points

Women in developing countries play a central role in guaranteeing family food security and provide most of the labour for potato production.

Andean women possess a unique reservoir of knowledge and skills in domesticating wild potatoes and adapting new varieties.

New strategies are helping to empower small-scale farmers and ensure that gender issues are incorporated in potato development policies and programmes.

Since the beginning of Andean agriculture, seeds have been associated with reproduction and femininity. The Incas believed the moon conferred fertility on women and moved *Pachamama* (Mother Earth) to germinate and offer up her potatoes (known as *Mama Acxo*) at harvest time. Men deposited the seeds and women received them, to harbour and nurse. In the Andes today, and in many other parts of the developing world, potato growing is still highly labour-intensive. Rural women provide most of the labour in both small- and large-scale potato production – from conservation and seed selection to planting, harvesting, storing and marketing.

China: Increasing gender awareness

In China, most potatoes are grown in mountain areas of Inner Mongolia and Shaanxi provinces, both as a staple food and as a cash crop. Research in Wuchuan County, Inner Mongolia, shows how the labour-intensive nature of potato production, coupled with strong gender inequalities, can pose a threat to the sustainability of local livelihoods.

Says Zhang Ailian, a woman farmer: "Potato growing is very tiring, especially at harvest time, and the burden of household tasks is already very heavy. The Agriculture and Animal Husbandry Bureau provides technical training in potato production, but heads of the village usually tell men to attend. Women make up fewer than 10 percent of total participants."

A project in Wuchuan is working to ease the burden of potato production on women by supplementing agricultural training with gender-sensitive materials. The project uses participatory approaches such as "farmer field



A group of farmers harvests potatoes near Cajamarca. Photo: © CIP

schools", and brings gender issues into potato development policies. It advocates a more equitable division of labour and financial decision making powers for women, and facilitates their access to extension services and training.

Peru: Women as conservationists

In the high-altitude Peruvian Andes, the genetic diversity found in hundreds of native potato varieties guarantees rural communities' food security. Over centuries, Andean farmers and the descendants of *ayllu* family groups, primarily women, have selected countless varieties of potato to preserve and enhance plant diversity, allowing them to cultivate in different agro-ecological zones and cope with pests, diseases and climatic changes. The "bitter potato", for example, is the result of crossing with frost-resistant varieties adapted to the freezing temperatures of the *Puna* agro-ecological zone.

Male migration to urban centres has left women farmers responsible for almost 70 percent of family farm work. In the Chetilla community in Cajamarca, the



Andean women also handle marketing. Photo: © FAO

tasks of seed selection and storage are exclusively women's. Their participation in seed fairs is invaluable in preserving Andean potato biodiversity. Surveys have found that women attending fairs are able to identify up to 56 different varieties. However, the heavy burden placed on women in potato production highlights the need for a more equitable division of labour to ensure the conservation of agro-biodiversity.

Uganda: Enabling rural innovation

Potatoes have become an important staple and cash crop in sub-Saharan Africa's highland zones, and Uganda is a major potato producer in the region. Virtually all households in southwestern Uganda grow potatoes, harvesting over 60 percent of the national crop. Most tubers are grown in highland areas of Kabale and Kisoro as a staple food and as the main source of income.

"Enabling rural innovation" is a gender-sensitive strategy being used in various development programmes. The idea is to empower both men and women farmers and rural communities to develop market



Potato cultivation is expanding in Africa. Photo: © FAO

opportunities. In Kabale, for example, farmer field school training covered integrated potato pest and disease management. It also helped the Nyabyumba United Farmers group to establish an enterprise that now supplies potatoes for french fries at fast-food restaurants in Kampala.

Gender roles in agriculture

FAO's Gender Plan of Action underscores the need for rural and agricultural development policies that acknowledge the roles of both men and women in achieving food security. The Plan aims at promoting gender equality in access to food, in the control over and management of natural resources and agricultural support services, in policy- and decision-making processes at all levels in the agricultural and rural sector, and in opportunities for on- and off-farm rural employment.

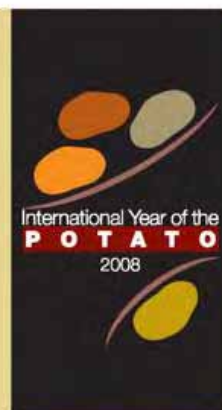
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The global potato economy

Developing countries are now the world's biggest potato producers – and importers – and consumer demand is shifting from fresh tubers to processed products



Key points

In 2005, for the first time, the developing world's potato production exceeded that of the developed world

Subsistence potato growing in developing countries is declining as producers reorient toward domestic and international markets

Global consumption is shifting from fresh potatoes to added-value processed products

In international trade, both the value and volume of traded processed products far outweigh trade in fresh tubers

Developing countries are net importers in international potato trade, which in 2005 was estimated to be worth US\$6 billion.

Despite its importance as a staple food and in combating hunger and poverty, potato has been neglected in agricultural development policies for food crops

Potato production in developed countries

especially in Europe and the Commonwealth of Independent States, has declined on average by one percent per annum over the past 20 years. However, output in developing countries has expanded at an average rate of five percent per year. Asian countries, particularly China and India, fuelled this growth.

In 2005, the developing countries' share of global potato output stood at 52 percent, surpassing that of the developed world. This is a remarkable achievement, considering that just 20 years ago the developing countries' share in global production was little more than 20 percent. Even so, world potato production and consumption are currently expanding more slowly than the global population.

Fresh potato consumption, once the mainstay of world potato utilization, is decreasing in many countries, especially in developed regions. Currently, more potatoes are processed to meet rising demand from the fast food, snack and convenience food industries. The major drivers behind this development include growing urban populations, rising incomes, the diversification of diets and lifestyles that leave less time for preparing the fresh product for consumption.

Potatoes are commonly regarded as a bulky, perishable commodity with high transport costs and limited export potential, confined mostly to cross-border transactions. These constraints have



In 2006, the world produced some 315 million tonnes of potatoes. Photo: © FAO

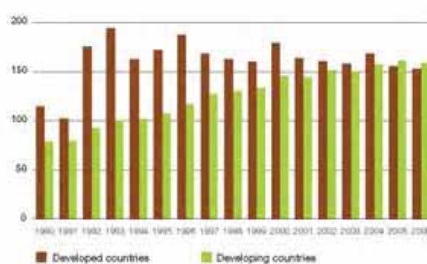
not hampered the international potato trade, which has doubled in volume and risen almost fourfold in value since the mid-1980s. This growth is due to unprecedented international demand for processed products, particularly frozen and dehydrated potato products. To date, developing countries have not been beneficiaries of this trade expansion. As a group, they have emerged as leading net importers of the commodity.

International trade in potatoes and potato products still remains thin relative to production, as only around 6 percent of output is traded. High transport costs, including the cost of refrigeration, are major obstacles to a wider international marketplace.

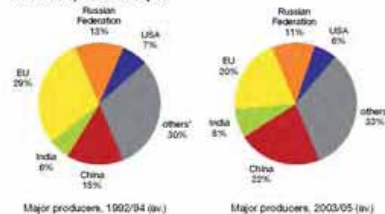
Trade policies

Ad valorem import tariffs are used to protect domestic potato markets. Other

World potato production 1990-2006

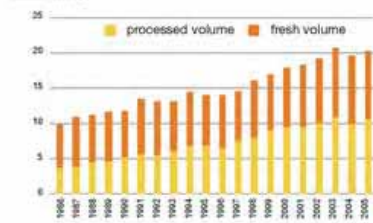


China and India now account for 30 percent of world potato output

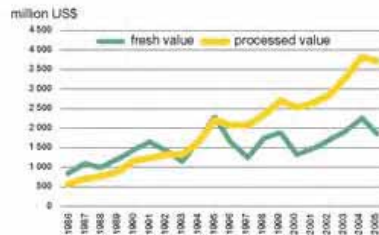


* Including Ukraine, Belarus, Canada, Islamic Republic of Iran, Turkey, Bangladesh, Peru, Brazil

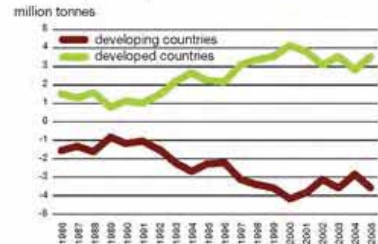
Imports and exports of processed products now dominate world potato trade
Global potato trade volume (tuber equivalent), 1986-2005
million tonnes



Global transactions worth close to US\$6 billion, driven by processed potatoes
Global potato trade value, 1986-2005
million US\$



Net trade position of developing countries continues to deteriorate
Potato net trade (exports-imports) in tuber equivalent, 1986-2005
million tonnes



policies that restrict access to markets include sanitary and phytosanitary measures and technical barriers to trade.

Import tariffs on potatoes and potato products are applied by most countries. The binding rates agreed under the aegis of the World Trade Organization vary considerably. Potato provides a classic example of "tariff escalation", where importing countries protect processing industries by levying higher duties on processed products than on raw material. By preventing countries from diversifying their export base into higher-value processed products, tariff escalation can therefore keep them "trapped" as providers of raw material.

Countries wishing to supply potato commodities to the international market – especially to the more lucrative developed country markets – also face

considerable hurdles in the form of food health standards and technical regulations. The Doha Development Round of trade negotiations recognizes the negative impacts of tariff escalation and contains important provisions aimed at ensuring that standards and regulations do not become de facto barriers to trade or hidden protectionist policies, while at the same time putting public health concerns foremost. Unfortunately, negotiations pertaining to the Doha agenda have suffered a series of setbacks, and agreement on a final solution has yet to materialize.

Potato potential

Potato's positive attributes, particularly its high nutritional value and potential to boost incomes, have not received the attention they deserve from governments. The lack of established marketing channels, inadequate institutional support and infrastructure, and restrictive trade policies are impediments to commercialization of the sector. National and international stakeholders need to place potato higher on the development agenda.

Product	WTO Bound Tariff (%)	
	Trade Weighted Average	Maximum
Fresh potatoes (inc. seed)	29	378
Frozen potatoes	16	414
Potato flour*	38	446
Potato starch	109	550

* includes flour, meal, flakes, granules and pellets

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Potato and food price inflation



The potato is a highly recommended food security crop that can help shield low-income countries from the risks posed by rising international food prices

Key Points



Prices of cereals are rising faster than those of potato and other root crops.

Countries with low levels of dietary diversity and high dependency on cereal imports could benefit greatly from expanded potato cultivation.

Potato flour can be blended easily with wheat flour, providing countries with a means of reducing costly wheat imports.

Potato is increasingly a valuable source of cash income for low-income farm households

Intense competition for reduced international supplies of cereals and other agricultural commodities is driving worldwide food price inflation, which brings with it the risk of food shortages and social unrest in low-income countries. One strategy that could help reduce the risk is diversification of food production to nutritious and versatile staple crops that are less susceptible to the vagaries of international markets. One such crop is potato.

Unlike rice, wheat and maize, the potato is not a globally traded commodity and its prices are determined usually by local supply and demand. A recent FAO survey in more than 70 of the world's most vulnerable countries found that inflation in potato prices is much lower than that for cereals. The potato is, therefore, a highly recommended food security crop that can help low-income countries ride out turmoil created by food price increases.

Potato for nutrition – and income

In many developing countries, the poorest and most undernourished farm households depend on potatoes as a primary or secondary source of food and

nutrition. These households value potato because it produces large quantities of dietary energy and has relatively stable yields under conditions in which other crops might fail.

The potato is highly adaptable to a wide variety of farming systems. With its short vegetative cycle – high yields within 100 days – it fits well into double cropping systems with rice, and is also suitable for intercropping with maize and soybeans. Potatoes can be grown at altitudes of up to 4 300 m and in a variety of climates, from the barren highlands of the Andes to the tropical lowlands of Africa and Asia.

Potato is also rapidly becoming a valuable source of cash income – a primary requisite of food security - for many small scale producers. In many developing countries, growth in urban populations and incomes and the diversification of diets have led to rising demand for potatoes from the fast food, snack and convenience food industries. The structural transformation of agriculture-based economies into more urbanized societies opens up new market opportunities for potato growers

FAO Cereal Price Index

1998-2000=100



Rising prices of maize, wheat and rice pose a threat to low-income countries

and to their trading and processing partners in the value chain.

Investing in potato production

With its adaptability to a wide range of uses, the potato has a potentially important role to play in the food systems of developing countries. However, policy makers have traditionally focused on cash crops for export and on cereals, leaving potato and other root crops at the periphery of agricultural development efforts. Redressing this imbalance is important if potato sectors are to thrive.

Investment in potato production should be considered as insurance against international market turbulence and as a food security safeguard. In the current climate of high food prices, it is often forgotten that until recently international prices for cereals had reached historic lows when adjusted for inflation. A boom followed by bust in cereal prices could easily undermine investments in the potato sector if consumers revert back to purchasing cheap, subsidized imported cereals.

Strengthening the potato 'value chain'

In developing countries, potatoes are often sold through fragmented marketing chains with little co-ordination and a lack of market information, giving rise to supply disruptions and high transactions costs. Many small scale farmers are excluded from markets owing their low yields, and inadequate storage and transport. Inefficient and unfair pricing discourages them from making on-farm investments in production.

Enhancing the value chain requires substantial public and private investment, especially in breeding programmes and in infrastructure to support and co-ordinate activities along the chain.

Production initiatives can be strengthened by research focused on specific end uses, rapid multiplication of good quality planting material, and varieties with pest and disease resistance. Producers of potato seed tubers need to offer yield-improving and input-saving technologies that boost yields and



reduce costs. The formation of producer groups would help farmers share expertise and strengthen their bargaining power. Production would also benefit from improvements in the supply of irrigation water and chemical fertilizers, and in cold storage and transport infrastructure.

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