



SECTION 1

Factors constraining the potato subsector

In the years ahead, world potato production is expected to grow at a rate of 2.5 per cent a year, presenting opportunities for expanded utilization and opening up new market segments. To realize the full potential of this crop, developing countries must address both supply- and demand-side constraints.



**POTATO MARKET
IN KASUNGU, MALAWI.**
(PHOTO: ANNE LI)

Technical factors

The potato's biological characteristics

Many constraints derive from the biological characteristics of the potato itself. These include the low multiplication rates of seed tubers, and the technical difficulties and costs associated with maintaining seed quality through successive multiplications, owing to the potato's susceptibility to soil and seed-borne insect pests and diseases. Seed tubers are also bulky: two to three tonnes per hectare is the typical seed requirement. Stringent phytosanitary restrictions limit the movement of potato germplasm, seed tubers and fresh ware potatoes. Potatoes have high fertilizer requirements but low utilization efficiency. Post-harvest, fresh potato tubers deteriorate quickly in tropical and subtropical environments, especially in the lowlands.

Lack of efficient seed systems

Many developing countries lack efficient systems for the regular multiplication and distribution of certified seed tubers and the rapid deployment of new, improved varieties. Causal factors include the limited technical capacity of human resources, lack of managerial expertise and inadequate resource allocations to seed systems and the potato subsector in general. As a result, farmer-based seed systems are still common, and have managed to supply planting material of limited quality over the years, and contributed to expanding cultivation of the crop. Farmer seed systems face many challenges, but also offer an opportunity to

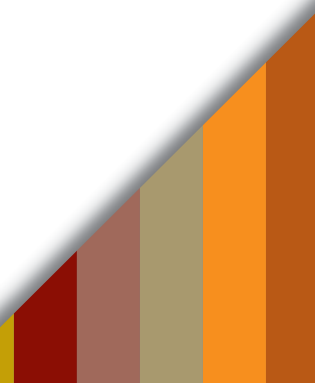
improve seed supply, provided suitable training is available and links with the formal sector are established.

Diseases and insect pests

Diseases and insect pests are another major constraint. New strains of late blight have reached many developing countries and continue to spread. Late blight constitutes the most serious threat to increased potato production. Second to late blight in importance, particularly in warmer, more tropical regions, is bacterial wilt. The impact of insect pests varies between regions. Major insect pests include aphids, tuber moths, leaf miners, Colorado potato beetle and Andean potato weevil.

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Export markets open in USA and Europe

The US government's African Growth and Opportunity Act (AGOA) provides preferential access for more than 1,800 tariff

lines, including agricultural commodities, from designated sub-Saharan African countries. The Everything But Arms (EBA)

initiative of the European Union (EU) eliminates import tariffs and restrictions on numerous goods, including agricultural products, from least developed countries provided that plant health regulations are met. EBA grants duty-free access for imports from most Less Developed Countries, except for a few sensitive commodities (e.g. bananas, sugar and rice) that will be liberalized gradually. Most of the commodities included in EBA previously received duty-free access to the EU under preferential programmes such as the Lomé/Cotonou Agreement.



**LOCAL TRANSPORTATION
OF POTATOES TO MARKET
IN MYANMAR.**
(PHOTO: ZIN MIN)

Socio-economic factors

High production costs and lack of credit

Compared to other food crops, production of potatoes is capital-intensive, requiring the purchase of large quantities of bulky seed and the application of high-cost inputs such as fertilizers and pesticides. With limited access to credit and few means of mitigating the risks of taking out loans, small-scale farmers find it difficult to compete in potato production. The current global financial crisis could leave a great number of farmers with little money and no credit to invest in production.

Price instability

With potato becoming increasingly a cash crop, small-scale potato growers are vulnerable to abrupt changes in input and output prices. Seasonal and year-to-year price movements can affect individual small growers who lack the financial resources and resilience of larger producers and cooperatives.

Inefficiency of local markets

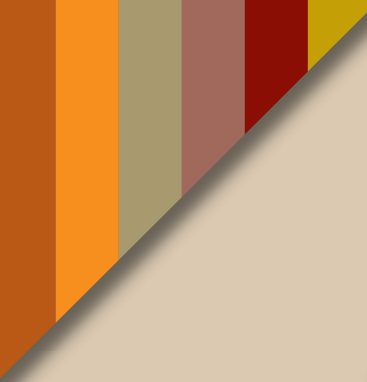
Potato prices are usually determined by supply and demand, not the vagaries of international markets as in the case of cereals. It is, therefore, a crop that can help low-income farmers and consumers to ride out episodes of food price inflation, such as that experienced worldwide in 2007-08. However, the profitability of potato depends on efficient local markets and measures to control overproduction.

Limited access to higher value markets

To be successful, small-scale potato growers need access to profitable emerging domestic markets – such as the rapidly growing processing segment – as well as to potato export markets. However, access to domestic markets is often restricted by the marketing power of foreign suppliers, while exports are constrained by trade barriers in developed countries to processed products from the developing world. However, there are encouraging “success stories” that illustrate how small-scale producers can increase production and expand their market share. In India, potato growers who adapted new technology with the support of McCain Foods Ltd more than doubled their yields and incomes. Other private industries, including small businesses, have launched potato chips made from coloured native potatoes that were prototyped by CIP in order to promote the sustainable use of biodiversity in the Andean Region. Recent legislation in the USA and Europe provide greater access to agricultural products from the developing world.

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Policy and institutional factors

Neglect of the potato subsector

With a few notable exceptions – such as Ethiopia – most developing countries have policies toward the potato subsector, and especially small-scale producers, that can be best characterized as “benign neglect”. Little or no public investment is targeted at integrated strategies for crop improvement, value addition and marketing schemes or the potato production-processing-marketing chain. Many countries lack adequate seed production systems backed by certification and seed laws. Breeding rights are often not respected, reducing incentives to breeders to create new adapted and resistant varieties. In many areas, poor infrastructural facilities and poor access to markets are also major challenges to expansion of potato production and its profitability.

Inadequate capacity building initiatives

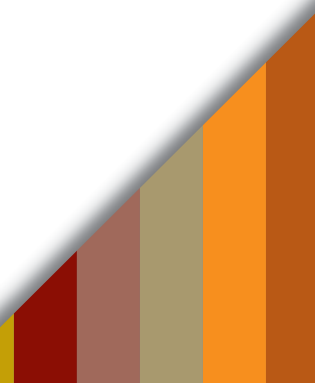
The potato has attracted private sector investment in the crucial area of seed multiplication and seed systems in only a few countries. Support for programmes for the diffusion of new varieties and for the scaling up of existing integrated disease and insect pest management technologies and methodologies is generally inadequate. Programmes to upgrade the skills of potato growers need to be matched by government efforts to create, monitor and enforce regulations on pesticide use and the spread of pesticide or fertilizer residues into water supplies, which are major constraints to the sustainability of potato production systems.

Lack of support to farmer organizations and entrepreneurs

Support for potato farmer groups and associations and for local entrepreneurship is lacking in many countries. In Bangladesh and Pakistan, powerful lobbies represent the most serious obstacle to the development of a local seed potato industry. One notable exception is Argentina, where efforts are being made by public and private sector to improve seed quality and promote variety development, and to transfer technology for integrated crop management to its contract growers.

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An aerial photograph of a terraced potato field in a mountainous region. The field is divided into numerous rectangular plots, each with rows of young potato plants. The terraces are built into the side of a hill, and the background shows a dense forest of tall trees. The overall scene is lush and green, with the brown soil of the terraces providing a contrast to the vibrant green of the potato plants.

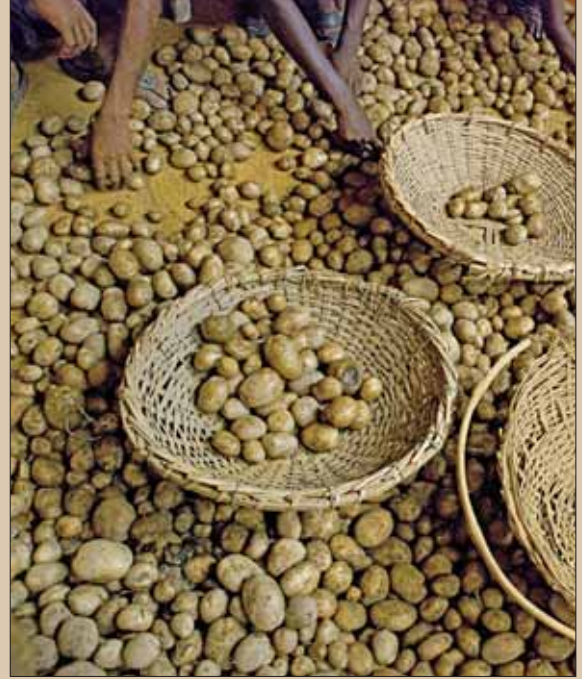
SECTION 2

Good Agricultural Practices and potato production

The term Good Agricultural Practices (GAPs) refers to principles and codes of practice that are applied to on-farm production and post-production processes and aim at ensuring safe and healthy food and non-food agricultural products, while taking into account economical, social and environmental sustainability.

The cost of GAPs

With most GAP applications, production costs are lower, losses reduced, and use of inputs rationalized as a better management system is put in place. The cost of private GAP standard certification (e.g. for GlobalGAP or Tesco Nature's Choice) may be higher owing to stricter requirements. However, this does not necessarily have to be the case with adoption of good practices per se. Generally, there is no higher cost to the consumer – that is why retailers and commercial farming are rapidly adopting GAPs. Where adoption of GAPs entails additional costs, the benefits in economic, social or environmental terms are usually higher.



SORTING OF POTATO IN INDIA.
(PHOTO: RINI MAJUMDAR)

GAP concepts and principles

GAPs may be applied to a wide range of farming systems and at different scales. They are applied through sustainable agricultural methods, such as integrated pest management, integrated water and fertilizer management, and conservation agriculture. GAPs are based on four principles:

1. to economically and efficiently produce sufficient quantities of safe and nutritious food;
2. to sustain and enhance ;
3. to maintain viable farming enterprises and contribute to livelihoods;
4. to meet the cultural and social needs of society.

GAP applications are being developed by governments, NGOs and the private sector to meet the needs of growers and processors and for other specific purposes. They provide the opportunity to assess and decide on which to follow at each step of the production process.

It is important that GAPs are applied in a coordinated way. For each agricultural production system, GAPs should be part of a comprehensive management strategy, providing for adjustments when needed in response to changing conditions. The implementation of such a management strategy requires knowledge, planning, measuring, monitoring and record-keeping at each step of the production process. Adoption of GAPs may sometimes result in higher production, processing and marketing costs, and higher prices for the

consumer. To minimize costs, while maintaining the quality and safety of food products, participatory technical training and advice can be used to inform farmers of new technologies that will benefit them.

Information on options for GAP adoption would be facilitated through the use of common databases and information exchange platforms on available enabling technologies and integrated production techniques for different major agro-ecological areas.

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Examples of GAPs

Soil management

- * Reduce wind and water erosion through hedging and ditching.
- * Apply fertilizers at appropriate moments in adequate doses (e.g. based on soil analysis and crop requirement) to avoid extra costs and possible run-off and leaching.
- * Maintain or restore soil organic content through application of manure, use of grazing and/or crop rotation .
- * Reduce soil compaction by avoiding use of heavy machinery.
- * Maintain soil structure by limiting heavy and sometimes unnecessary tillage practices, and through use of cover crops such as pulses.

Water use efficiency

- * Use minimum or zero-tillage and maintain soil cover to reduce soil evaporation and improve soil structure and water infiltration.
- * To avoid water loss by drainage, schedule irrigation and monitor plant needs and soil water reserve status.
- * Prevent soil salinization by matching water input to needs, allowing some drainage and recycling water whenever possible.
- * Avoid excessive drainage and fertilizer run-off.
- * Maintain permanent soil cover in winter to avoid nitrogen run-off and wind erosion that contributes to soil degradation.
- * Carefully manage the water table by limiting withdrawals.
- * Avoid soil compaction (e.g., caused by too many passes of farm machinery) which can cause water logging and lead to emergence of potato diseases during storage.

GAPs in the potato subsector

Appplied to the potato subsector, GAP principles imply that potato production:

1. takes place in an economically efficient way;
2. contributes to food security by providing quantity and nutritional quality for a balanced food supply;
3. along with post-harvest handling and processing, ensures a safe food supply to consumers;
4. conserves the natural resource base;
5. does not lead to emissions that endanger the environment and biodiversity;

6. enhances potato biodiversity and ensures a sufficient genetic base for varietal adaptation and resistance;
7. supports viable farming enterprises and contributes to livelihoods;
8. meets the cultural and social needs of society.

Several approaches can be utilized to operationalize GAP principles in potato production. The most stringent one attaches criteria to each principle, with indicators and indicator values. For example, the following table summarizes criteria, indicators, indicator values and GAPs that could be used in implementing principle 4 above:

Conserving the natural resource base

<i>Criteria</i>	<i>Indicators</i>	<i>Indicator values</i>	<i>GAPs</i>
conserve soil organic matter	percentage of soil organic matter	5% organic matter	apply compost, manure or green manure to keep soil organic matter at the desired level
ensure replenishment of groundwater used by irrigation	depth of the water table	5 m below topsoil level	do not over-irrigate from deep wells and tap other water sources or grow potatoes during a wetter period of the year if the threat of disease is not high.
avoid soil erosion	surface run-off of soil particles	0 kg soil loss per square meter per year	apply contour farming, make terraces and use minimum or zero-tillage implements

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“PACHAMAMA HUELLA” -
LAND PREPARATION
FOR POTATO IN BOLIVIA.
(PHOTO: MANUEL SEOANE
SALAZAR)



Production decision factors

In potato-based systems in developing countries, the GAP concept can be associated with critical production decision factors and recommendations.

Environment and production zones

The potato is essentially a “cool weather crop”, with temperature being the main limiting factor. In tropical areas, potato should be grown where the climate is tempered by altitude (1 500 – 4 200 m) or at lower altitudes provided the crop is grown during the cool season.

The ideal condition for tuberization is a night temperature of around 16°C, while optimum yields are obtained where mean daily temperatures are in the 18-20°C range. Loose, moist and well-drained slightly acid soil (with pH of 5.0-5.5) or volcanic upland soils are preferred. The water supply for the potato crop should be regular, especially from the stage of tuber initiation until the end of tuber enlargement.

Cultivation methods

A successful potato crop depends on judicious cultural practices. These include good knowledge of variety purity and characteristics such as dormancy duration, the physiological condition of seed potato tubers (well sprouted and 30-80 g in weight, depending on variety) and resistance to the main transmissible potato diseases and nematodes.

Potatoes are best grown in rotation. In the Andes, it is usually the first crop in the

rotation. In other regions, it can be planted after cereals and before legumes, but not with crops (e.g. tomato and other solanaceae) that are susceptible to the same pathogens as the potato. Sometimes natural fallow is necessary to prevent soil impoverishment and the build-up of potato-specific diseases and insect pests.

Soil preparation for the potato crop should be adequate with minimum soil disturbance. Naturally loose soils, and loamy and sandy loam soils that are rich in organic matter with good drainage and aeration, are the most suitable.

Planting depth, density and spacing depend on the variety chosen and tuber size, and should allow for shallow inter-row ridging, when required. Usually, about two tonnes of seed tubers are planted per hectare.

To give the crop a competitive advantage, weeding should be performed after full crop emergence (about 4 weeks after planting) and after the plants have reached a height of about 20 cm. Shallow ridging is done subsequently to prevent the stolons becoming aerials, and to protect tubers against insect pests, disease infection and greening. Crop rotation and careful chemical control with herbicides, applied at minimum lethal doses, may be part of an integrated weed management system, although in most developing countries weed management is usually carried out manually.

A few basic precautions against insect pests and diseases can help avoid great yield

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**POTATO HARVESTING
IN PANUTY DISTRICT,
NEPAL.**
(PHOTO: G.M. BAKASH)

and quality losses. They include crop rotation, use of resistant varieties and healthy, certified seed tubers (if available or at least seed from a reputed source or through positive selection), and integrated disease and insect pest management, which involves regular monitoring of aphid and thrips vectors, other insects and natural enemy populations, and chemical spraying only when necessary.

Fertilizer application during the stages of pre-planting, planting or crop growth should be determined by soil nutrient availability, taking into account the potato's high demand for potassium, phosphorus and magnesium deficiencies in acid soils. The NPK ratio 1-1-1 is usually a wise choice to avoid spoiling tuber quality. The potato can benefit from the application of organic manure at the start of a new rotation as it provides a good nutrient balance and protects soil structure from compaction and erosion.

As soil moisture must be maintained at a relatively high level in production of potatoes, compared to other crops, irrigation may be required where rainfall is limited.

Harvesting

For most commercial varieties, yellowing of the potato plant's leaves and easy separation of tubers from stolons indicate that the potato crop has reached maturity. If the potatoes are to be stored rather than consumed immediately, they are left in the soil to allow their skin to harden – hard skin also help seed potatoes to resist storage diseases. However, leaving tubers for too long in the ground increases their exposure to the fungal disease black scurf and increases the risk of losing quality and marketable yield.

To facilitate harvesting and stop tuber growth, potato vines should be removed two weeks before the potatoes are dug up. Depending on the scale of the production, potatoes are harvested using a spading fork, a plough or commercial potato harvesters that unearth the plant and shake or blow the soil from the tubers. During harvesting, especially if it is done mechanically, it is important to avoid bruising or other injuries, which provide entry points for storage diseases and reduce the commercial, processing quality and storability of the tubers.

In suitable environments and where growing conditions are adequate, commercial yields are in the range of 40–60 tonnes per hectare. In many developing countries, however, they are far below this figure, with national averages of about 10-20 tonnes per hectare.

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A large rectangular area of graph paper with a light beige background and a grid of thin, light brown lines. The grid is approximately 20 columns wide and 30 rows high, providing a space for handwritten notes.

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Storage and transport

In the tropics and where refrigerated storage is not available, seed tubers should be stored under diffuse light in order to maintain their sprouting capacity and to encourage development of vigorous sprouts. In regions with only one cropping season per year and where storage of tubers from one season to the next is difficult without the use of costly refrigeration equipment, off-season planting may offer a solution. Importation of seed tubers is common in these regions, but may entail higher costs and risks of late delivery and deterioration in tuber quality along the marketing chain.

Ware potatoes should be kept at a temperature of about 6 to 8°C, in a dark, well ventilated environment with high

relative humidity (85 to 90 percent). For processing purposes, such as the production of french fries, storage temperatures may range up to 10°C to reduce the risk of increasing sugar levels, which are responsible for a dark colour during frying. Potato darkening can also be caused by an excess of nitrogen in the fertilization formula.

During transport of seed tubers and ware and processing potatoes, it is important to avoid bruising by reducing drop height, lining containers with rubber or other soft material, and avoiding extreme temperatures. Tubers should be protected against unexpected rainfall and snow, which can occur at high altitudes.