

# **Variety. The key driver of demand for seed potatoes in The Philippines.**

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## **Abstract**

With the agro-ecological conditions in The Philippines being vastly different from the temperate growing conditions under which the majority of the world's potato varieties have been selected, a farmer's choice of variety will have a profound impact on the productivity and profitability of the crop. Variety was found to be the most important factor influencing a Filipino potato farmer's decision to purchase seed. The physical characteristics of the tuber (tuber size, shape, skin colour and flesh colour) were found to be the most important factor influencing the farmer's choice of variety. Suitability to the environment was the second most important factor, indicating that farmer's are constantly searching for new, better adapted varieties which will perform better in the field. However, despite the expansion in both the fast food industry and the snack food market, the suitability of the variety for processing was surprisingly the least important factor in the farmer's choice of variety.

*Key words:* environmental adaptability, physical characteristics, varietal choice, *Solanum tuberosum*

## **Resume**

Les conditions agro-écologiques dans Les Phillipines étant grandement différentes des conditions de températures grandissantes dans lesquelles la majorité du monde de la variété de la pomme de terre a été sélectionnée, la variété de choix du cultivateur aura un profond impact sur la productivité and la rentabilité de la culture. Variété a été prouvée le plus important facteur influençant la decision du cultivateur Phillipien d'acheter les graines. Les caractéristiques physiques du tuber (sa taille, sa forme, la couleur de sa peau et la couleur de sa chair) étaient les plus important facteurs influençant la variété du choix du cultivateur. Un environnement approprié était le deuxième facteur le plus important, indiquant que les fermiers recherchaient constamment de nouvelles variétés mieux adaptées. Cependant, malgré l'accroissement dans l'industrie de la restauration et le marché du casse-croût, la variété appropriée pour le traitement étaient étonnamment le dernier important facteur dans la variété de choix du cultivateur.

*Mots Clés:* *L'environnement adaptable, caractéristiques physiques, variété de choix, solanum tuberosum*

Introduction.

Potato production in The Philippines is increasing. Population growth and urbanisation has expanded the market for food crops and rising per capita incomes have stimulated the demand for more exotic foods to diversify diets (Horton 1987). Nonetheless, perhaps the most significant factor influencing potato consumption in The Philippines has been the growth in the fast food franchises (Perez 1995) and the increasing consumption of snack foods.

Potato production in The Philippines remains centred in the highland mid-elevation areas of Benguet and Mountain Province in Northern Luzon (Crissman 1989). Traditionally, as much as 86% of the land planted in potatoes has been located in the Cordilleras, but more recently, the proportion has declined to around 76% (Gayao and Sim, undated). However, the apparent reduction in the area cultivated is not due to any real decline, but rather to the expansion of potato production into other suitable highland regions in Northern and Southern Mindanao, the Central Visayas and the lowland regions of Ilocos Norte and Cagayan valley (Perez 1995). Currently, some 5,680 hectares are devoted to potato production in Benguet and Mountain Province (Gayao and Sim, undated), however, it is becoming increasingly more difficult to expand production in the region because of the limited availability of suitable land. As production shifts to more marginal areas and as more of the forest cover is removed, greater amounts of land are becoming subject to erosion. Because of land limitations, few potato growers adhere to recommended crop rotations, relying instead on greater quantities of purchased inputs (fertilisers and pesticides) to intensify production and to control the increasing incidence of bacterial wilt and late blight. However, productivity is also constrained by poor quality planting material, the high cost of planting material, inefficient farm practices and poor infrastructure, especially transport, which increases both production and marketing costs.

While many authors acknowledge that the lack of good quality seed is the major constraint to potato production in The Philippines (Balaoing and Lazo 1967; Batugal et al 1988; Crissman 1989; Mariano et al 1991; Aromin et al 1993; Callueng et al 1993; Sana et al 1993; Rasco and Aromin 1994; Rasco 1994), the productivity of the crop is also influenced by soil fertility (Rasco and Aromin 1994), the availability and frequency of irrigation (Crissman 1989, Mariano et al 1993; Pangilauan et al 1993), the availability and cost of fertilisers, pest and disease control (Crissman 1989) and the suitability of the variety (Altoveros 1992).

While the average yield now exceeds 16 tonnes per hectare (Gayao and Sim, undated), the yields achieved in The Philippines are still less than half those achieved in the USA (38 tonnes per hectare) or The Netherlands (43 tonnes per hectare)(CIP 1998). While there is no reason to presuppose that increases in productivity will not continue to improve, it is most unlikely that potato farmers in The Philippines will achieve the levels of productivity attained in the temperate zones, due to the shorter growing season and higher temperatures reducing photosynthetic efficiency (Horton 1987).

### **Variety. Opportunity or constraint?**

The majority of potato varieties cultivated commercially throughout the world, have been bred and selected under temperate growing conditions (Beukema and van der Zaag 1990). When these varieties are cultivated in different agro-ecological environments, many react strongly to the environment and only a few characteristics remain the same. In a country with different climatic zones and different growing conditions, these varieties must be re-evaluated in terms of those characteristics which are most important in the situation. For most potato varieties, short days and moderate temperatures stimulate tuber initiation (Horton 1987). When temperatures exceed 25°C, the net rate of photosynthesis decreases and generally, if night temperatures remain above 20°C, tubers will not form. Furthermore, the tuber bulking rate is related to the hours of daylight, hence bulking is more rapid in long days. However, in the tropics, the day length and the growing period for potatoes are shorter.

To yield well in the tropics, a variety must be able to cope with the higher temperatures, the higher humidity, a shorter day length and a shorter growing period, higher levels of pests and

diseases, and grow well with only minimal inputs (Renia 1992). The variety must also have a good storage capability and fit into the length of the cropping season (Horton 1987). In the tropics, early maturing varieties are generally preferred for it is possible to achieve a multiple number of crops and there is always the risk of yields being suppressed by unfavourable environmental conditions and pest and disease infection. Furthermore, farmers often sacrifice yield by harvesting early to achieve higher prices, or to clear the field for another crop. Even where the growing season may enable a later maturing, high yielding variety to be grown, or where it is possible to achieve a multiple number of crops, farmers often prefer to cultivate early, short duration varieties.

In selecting a suitable variety, farmers generally select higher yielding varieties with resistance to disease, good eating quality and the desired tuber characteristics (skin colour, flesh colour, tuber size, tuber shape and storage capabilities)(Horton 1987; Crissman 1989; Callueng et al 1993; Demonteverde et al 1993). Bos (1998) suggests that market price, tuber size, tuber shape, productivity per hectare, the cost of seed, suitability to the environment, short maturity and resistance to disease are the most important criteria potato farmers use in their decision to plant a particular variety.

However, farmers seldom use a single criteria in selecting or rejecting a variety, rather, the decision is made with consideration to a number of both positive and negative attributes (Callueng et al 1993). All varieties have some inherent weakness, for the ideal variety simply does not exist (Beukema and van der Zaag 1990).

Furthermore, the variety a farmer grows often reflects historical patterns of colonisation and trade, as well as the production environment, the cropping system, food requirements and consumers preferences (Horton 1987, van der Zaag 1990). Most consumers want big potatoes, but medium tubers often sell at higher prices because the larger ones are either cracked or hollow (Horton 1987). Some consumers want a high dry matter because the potato holds its shape on cooking, whereas other prefer a low dry matter because they want it to disintegrate. In The Philippines, the larger tubers are purchased for processing, medium sized tubers are preferred for home consumption and the small grades are often retained by the farmer for use as seed ( Crissman 1989). Consumers often prefer a particular variety, therefore it may prove more profitable for the farmer to grow an established, less productive variety, because of the higher prices received (Horton 1987; van der Zaag 1990). Processors particularly are inclined to pay significant price premiums for favoured varieties (van der Zaag 1990). However, not all potatoes are suitable for both table consumption and processing and the thus the demand for a particular variety will reflect changing patterns of utilisation.

Granola is the most widely grown variety in The Philippines (96%)(Gayao and Sim undated). It is extensively cultivated because it is early maturing, high yielding and produces a high proportion of large tubers. Granola also has some resistance to nematodes, however, it is not generally regarded as being suitable for processing. While there is no local variety currently available which has all the desired characteristics, the adoption of new varieties has often been very rapid (Crissman 1989). One of the main reasons given for the rapid adoption of new varieties is farmer's frustration with the poor quality of existing seed material (Callueng et al 1993). Furthermore, because of the difficulties experienced with the formal seed system, the distribution of most new varieties is highly localised (Crissman 1989). Bos (1998) suggests that there is a general reluctance for farmers to provide information on new varieties to other farmers because of the perceived marketing advantages the farmer may obtain.

Feder, Just and Zilberman (1985) suggest that the major constraints to the adoption of a new variety in a developing country include; the lack of credit, limited access to information, the farmer's aversion to risk, inadequate farm size, inadequate incentives (associated with land tenure), insufficient human capital, the absence of machinery to relieve labour shortages, the chaotic supply of complementary inputs, and, poorly developed transportation infrastructure. However, in The Philippines, the availability of quality seed at planting time may also influence the demand for seed. The lack of seed often means that the farmer will be forced to plant whatever variety is available at that time (Crissman 1989).

This paper will seek to identify those factors which most influence a farmer's decision to purchase seed tubers. Anticipating that variety will be one of the most important factors influencing the farmer's decision to purchase, the paper will then seek to identify what characteristics farmer's look for in their most preferred variety. Finally, the paper will investigate how consistent these variety selection criteria are among the farmers, for it is highly probable that various demographic variables (experience, education, participation in farm schools, membership of farmer cooperatives), farm characteristics (size, on-farm storage capacity) and the intended market will influence the farmer's choice of variety.

### **Methodology**

From January to July 1999, 235 potato farmers in the highlands of Northern Luzon were asked to respond to a prepared questionnaire. Farmer's were asked to provide information about themselves, their current farming practices and intended markets. Particular emphasis was given towards the various factors and constraints that most influenced a farmer's decision to purchase seed, their choice of seed supplier and the nature of any long-term relationship(s) with seed suppliers. Given that the majority of farmers in The Philippines speak English, the survey instrument was written in English and the interviews were conducted in English, although farmer's often responded in their native dialect. The interviews were conducted in the farmer's homes by a skilled technician employed by the Highland Agriculture and Resources Research and Development Consortium, Benguet State University.

Farmer's were selected from one of five municipalities in proportion to the area of the potato crop planted (Gayao et al 1997). However, in order to approach farmers, it was first necessary to seek permission from the head man in the village who also provided contact names and addresses of suitable respondents. Contact names and addresses for additional respondents were sought during the interviews with farmers. In the absence of any reliable list of potential respondents, such methods of data collection are not uncommon in the developing countries (Della Vedova and Brieva 1995).

Farmers were asked to rate the importance of 35 variables believed to influence the farmer's decision to purchase seed potatoes. Farmer's were asked to respond on a scale of 1 (not at all important) to 7 (very important). Scales were developed from previous research reported by Altoveros (1992), Balaoing and Lazo (1967), Beukema (1990), Beukema and van der Zaag (1990), Crissman (1989), Crissman and Hibon (1996), Della Vedova and Brieva (1995), Haverkort (1986) and Monares (1981).

Farmers were then asked to rate a further 20 variables believed to most influence their choice of a particular variety. Farmer's responded on a scale of 1 (not at all important) to 7 (very important). Scales were developed from previous research reported by Altoveros (1992), Aromin et al (1993), Balaoing and Lazo (1967), Batugal et al (1988), Beukema (1990),

Beukema and van der Zaag (1990), Bos (1998), Callueng et al (1993), Crissman (1989), Crissman and Hibon (1996), Della Vedova and Brieva (1995), Haverkort (1986), Horton (1987), Kloos and van der Zaag (1988), Lamont (1993), Monares (1979), Panglilauan et al (1993), Rasco and Aromin (1994), Renia (1992), Sana et al (1993) and van der Zaag (1990).

After data collection, the information was encoded for subsequent computer analysis using the SPSS package. Scheffe's Test was performed to identify any significant difference in the rank order of importance of those 35 variables believed to most influence the farmer's decision to purchase and for those 20 variables believed to most influence the farmer's choice of variety.

Factor analysis (with varimax rotation and Kaiser normalisation) was then undertaken to identify any significant correlations between those variables influencing the farmer's decision to purchase seed and their choice of variety. To more clearly indicate which variables belonged to which construct, the reliability coefficient (Cronbach's alpha) was applied.

The resultant factors which influenced the farmer's choice of variety were then cross tabulated with those demographic and economic variables considered most likely to influence the farmer's choice of variety. Data was analysed using ANOVA.

## **Results and discussion**

Variety and obtaining a source of seed that was not contaminated with other lesser preferred varieties, were the two most important criteria influencing a potato farmer's decision to purchase seed tubers (Table 1). Such would suggest that, as anticipated, variety was the most important variable influencing the farmer's decision to purchase seed. However, between variety, seed purity and the next 20 variables, there was no significant difference between the means.

Horton (1987) shows how the productivity per hectare is derived by the length of the growing season and average tuber production per day. The quantity and size of tubers produced is determined by the number of tubers produced per stem and the number of stems per hectare. The number of tubers produced per stem depends not only the soil and weather conditions, but also on the farmers choice of variety. Thus, to obtain high yields, farmers need to plant the right variety for their location. However, productivity per hectare is also derived from the use of healthy seed. Balaoing and Lazo (1967) suggest that no aspect of growing potatoes is more important than the selection of the best possible planting material, for the yields obtained from different stocks of the same variety under the same conditions of culture, depends more upon the quality of the planting material than on any other single factor. Furthermore, Monares (1981) demonstrates how the use of high quality seed improves the productivity of traditional inputs such as labour, irrigation and cultivation practices.

Beukema and van der Zaag (1990) consider seed purity (not mixed varieties), seed size, physiological age and seed sanitation to be the most important variables that influence seed tuber quality. Because potatoes are vegetatively propagated, with each successive crop, the productivity of the seed generally decreases, due to the accumulation of disease (Monares 1981; Kloos and van der Zaag 1988; Beukema 1990). During the growing season, plants may become infected with either a systemic disease or a virus. Generally, those plants which become infected produce infected tubers, which, when replanted, produce infected plants which provide a potential source of infection for other plants (Beukema and van der Zaag 1990). The rate at which the seed degenerates determines the number of times the farmer can profitably use their

own seed (Beukema 1990). However, the rate of seed degeneration varies from region to region and from season to season (Beukema and van der Zaag 1990).

**Table 1. Importance of variables influencing a Filipino potato farmer's decision to purchase seed tubers.**

	Mean	SD
Variety	6.99 <sup>a</sup>	0.02
Seed purity (not mixed varieties)	6.98 <sup>a</sup>	0.14
Seed size	6.97 <sup>a</sup>	0.24
Origin of the seed	6.95 <sup>a</sup>	0.38
Availability of other farm inputs	6.93 <sup>a</sup>	0.29
Physiological age of the seed	6.92 <sup>a</sup>	0.44
Expected yield of ware potatoes	6.91 <sup>a</sup>	0.29
Market price of ware potatoes	6.91 <sup>a</sup>	0.37
Farmer's attitude to risk	6.90 <sup>a</sup>	0.45
Anticipated profitability	6.89 <sup>a</sup>	0.44
Rate of seed degeneration	6.88 <sup>a</sup>	0.45
Availability of credit	6.88 <sup>a</sup>	0.41
Freedom from disease	6.88 <sup>a</sup>	0.34
Guaranteed buy-back of ware potatoes	6.87 <sup>a</sup>	0.46
Anticipated future yields of ware potatoes	6.83 <sup>a</sup>	0.49
Availability of cash to purchase seed	6.82 <sup>a</sup>	0.51
Availability of farm labour	6.80 <sup>a</sup>	0.51
Availability of irrigation	6.74 <sup>a</sup>	0.57
Availability of seed at planting time	6.70 <sup>a</sup>	0.98
Uncertainty of price in the ware market	6.69 <sup>a</sup>	0.64
Seasonal variations	6.69 <sup>a</sup>	0.57
Cost of credit	6.64 <sup>a</sup>	0.82
Previous purchase	6.46 <sup>b</sup>	0.80
High cost of seed	6.40 <sup>c</sup>	0.74
Total quantity of seed required	6.37 <sup>d</sup>	0.61
Proximity to seed supplier	6.34 <sup>d</sup>	0.74
Relative price difference between seed and ware potatoes	6.32 <sup>d</sup>	0.91
Seed rate per unit area	6.16 <sup>c</sup>	0.66
High cost of certified seed	6.01 <sup>f</sup>	0.98
Cost of retaining seed	5.93 <sup>g</sup>	1.10
Anticipated losses in storage	5.82 <sup>h</sup>	1.04
Expected yield of seed potatoes	5.80 <sup>h</sup>	1.16
Yield difference between new seed and farmers seed	5.69 <sup>i</sup>	1.11
Pathogen tested (certified) seed	5.30 <sup>j</sup>	0.68
Imported seed	5.06 <sup>k</sup>	0.70

where 1.0 is least important and 7.0 is most important values with the same superscript are not significantly different at  $p = 0.05$

In the absence of a certified seed system, Crissman and Hibon (1996) consider seed origin to be an important dimension of seed quality. In most countries, there are traditional seed areas, often at high elevation, where the rates of seed degeneration are lower and seed may be grown at the

right time of the year so that by the time it is delivered to farmers, the seed is of the desired physiological age for planting. Furthermore, it is generally accepted that seed grown at higher altitudes behaves as young seed for a longer period of time. Young seed is more vigorous, later maturing and generally higher yielding (Horton 1987, Crissman 1989).

The other variables considered most important in the farmer's decision to purchase seed may be grouped under either their impact on productivity (other farm inputs, yield, future yield, availability of labour and irrigation), profitability (market price, profit, cost and availability of credit, availability of cash and guaranteed buy-back), or uncertainty (farmer's attitude to risk, the uncertainty of price in the ware market, seasonal variations in productivity and the availability of the seed at planting time). Since most farmers rated most of these variables as important in their decision to purchase seed, there was a strong possibility that significant correlations could exist between several of the variables.

Principal component analysis provided seven factors that collectively accounted for over 66% of the variation in farmer's responses (Table 2).

Factor 1 (risk reduction) captured 7 variables that collectively comprised various mechanisms potato farmers might use to reduce risk (proximity to the seed supplier, relative price difference, cost of certified seed and prior purchase) and various environmental factors (seasonal variations, uncertainty of price and the cost of credit) that create uncertainty in the environment. Hakansson and Wootz (1975) suggest that most buyers prefer to purchase from local sources. Local suppliers are generally less expensive and offer more dependable service than those located at a distance. Anderson, Chu and Weitz (1987) indicate that when the decision to purchase involves considerable risk, buyers prefer to purchase from those suppliers from whom they have purchased on previous occasions.

Factor 2 (financial loss) included 2 variables which will directly impact on the profitability of potato production (the cost of retaining seed and losses in storage) and 2 variables which potentially have a longer term impact (yield of seed and the yield difference between the farmer's own seed and the purchased seed). Where the yields are low, it is more difficult for the farmer to justify the use of high quality seed, for it is often more profitable to use poor quality seed (van der Zaag 1987).

Factor 3 (farm inputs) recognised that the farmer's decision to purchase improved seed was made with consideration to the availability of other complementary inputs including labour, irrigation, fertilisers, and chemicals for pest and disease control. Nevertheless, the length of time that the farmer can profitably use his own seed depends upon the initial quality of the seed, the agro-ecological conditions under which it is grown, the variety and the various measures the farmer takes to control the spread of disease (Beukema 1990).

Factor 4 (profitability) considered the impact of seed quality (origin and physiological age) and market prices on the profitability of the ware potato crop. However, this factor also considered the farmer's attitude to risk and their willingness to purchase seed, despite the uncertain seed quality and the uncertainty of price in the market.

**Table 2. Factors influencing a Filipino farmer's decision to purchase seed.**

Variable	Factors						
	1	2	3	4	5	6	7

Proximity to seed supplier	0.71						
Prior purchase	0.70						
Relative price difference	0.69						
Cost of certified seed	0.68						
Seasonal variations	0.63						
Uncertainty of price	0.56						
Cost of credit	0.51						
Yield of seed		0.86					
Cost of retaining seed		0.81					
Losses in storage		0.80					
Yield difference		0.79					
Rate of degeneration			0.70				
Availability of other farm inputs			0.70				
Farm labour			0.68				
Freedom from disease			0.60				
Irrigation			0.58				
Farmer's attitude to risk				0.81			
Profitability				0.68			
Market price				0.64			
Origin of the seed				0.63			
Physiological age of the seed				0.54			
Expected yield					0.87		
Anticipated future yields					0.71		
Guaranteed buy-back					0.65		
Availability of cash						0.70	
High cost of seed						0.56	
Availability of seed at planting time						0.56	
Availability of credit						0.51	
Seed rate						0.47	
Quantity of seed required						0.47	
Variety							0.91
Seed purity (not mixed)							0.87
Factor mean	6.45	5.81	6.84	6.91	6.87	6.55	6.99
Standard deviation	0.57	0.92	0.34	0.35	0.36	0.41	0.11
Eigenvalue	9.50	3.20	2.11	1.85	1.65	1.57	1.32
Cronbachs alpha	0.86	0.87	0.81	0.77	0.79	0.78	0.80
% variation	29.7	10.0	6.6	5.8	5.1	4.9	4.2
Cumulative %	29.7	39.7	46.3	52.1	57.2	62.1	66.3

Factor 5 (productivity) captured two variables that considered the expected yield and the anticipated future yield. Crissman and Hibon (1996) suggest that a farmer's decision to purchase improved seed is made knowing that the benefits will be realised over several seasons. However, the benefits arising from the increased yield will decline progressively as the seed degenerates. The additional variable, guaranteed buy-back, arises from the nature of the loan often arranged between seed suppliers and potato farmers, where the seed supplier undertakes to provide all of the production inputs with the understanding that they will be responsible for marketing the crop, subtracting the costs of production (plus interest) and returning the balance to the farmer (Crissman 1989; Gayao et al 1997).

Factor 6 (credit constraints) recognised that the majority of the small farmers have inadequate financial resources to purchase seed. The extent to which this a problem is influenced by the high cost of seed, the availability of cash, the availability of credit, the availability of seed at planting time and the quantity of seed required.

Factor 7 was comprised of two variables which considered the farmer's varietal preference and the need for seed purity (not mixed varieties). Factor 7 proved to be the most important factor influencing a Filipino potato farmer's decision to purchase seed. The very high factor mean and small standard deviation for each of the two variables suggested that this factor was important for all potato farmers.

In choosing between alternative varieties, the four most important attributes that Filipino potato farmer's sought from their most preferred variety was tuber size, tuber shape, skin colour and the suitability of the variety to the growing environment (Table 3).

**Table 3. Importance of criteria Filipino potato farmer's use in selecting a variety.**

Attribute	Mean	SD
Tuber size	6.96 <sup>a</sup>	0.28
Tuber shape	6.95 <sup>a</sup>	0.30
Skin colour	6.95 <sup>a</sup>	0.34
Suitability to the growing environment	6.94 <sup>a</sup>	0.37
New variety	6.91 <sup>a</sup>	0.54
Flesh colour	6.91 <sup>a</sup>	0.43
Price in the ware market	6.88 <sup>a</sup>	0.40
Vigorous growth	6.85 <sup>a</sup>	0.46
Fast maturing	6.82 <sup>a</sup>	0.42
Resistance to disease	6.81 <sup>a</sup>	0.43
Availability at planting time	6.74 <sup>a</sup>	0.51
Productivity per hectare	6.68 <sup>a</sup>	0.57
Variety traditionally grown	6.63 <sup>b</sup>	0.64
Eating quality	6.44 <sup>c</sup>	0.93
Cost of seed	6.33 <sup>d</sup>	0.72
Seed rate per hectare	6.17 <sup>e</sup>	0.68
Storage characteristics	5.67 <sup>f</sup>	1.05
Drought tolerance	4.73 <sup>g</sup>	1.06
Heat tolerance	4.62 <sup>g</sup>	1.02
Processing quality	4.55 <sup>g</sup>	0.70

where 1 is not at all important and 7 is most important  
values with the same superscript are not statistically different at  $p = 0.05$

The first three attributes (tuber size, tuber shape and skin colour) are no doubt related to the marketability of the tubers. Farmer's perceive that the market prefers large tubers, with a round, uniform shape and smooth, yellow skin (Callueng et al 1993; Sim et al 1997).

The suitability of the variety to the environment will impact upon both its productivity and profitability. Even the very best cultural practices seldom compensate for a poor choice of

variety (HARRDEC 1996). Those aspects which Filipino farmer's consider most important include vigorous growth, fast maturing and resistance to disease. Profitability is influenced by two dimensions; productivity per hectare and the price in the ware market.

Given that most farmers rated the majority of these variables as important in their decision to select their most preferred variety, there was a strong possibility that significant correlations might exist between several of the variables. Principal component analysis revealed four factors that collectively accounted for over 72% of the variation in farmer's responses (Table 4).

**Table 4. Factors influencing a Filipino potato farmer's choice of variety.**

	Factor			
	1	2	3	4
Fast maturing	0.865			
Resistance to disease	0.849			
Eating quality	0.819			
Productivity per hectare	0.796			
Price in the ware market	0.585			
Vigorous growth	0.570			
Tuber size		0.929		
Skin colour		0.877		
Flesh colour		0.836		
Tuber shape		0.833		
Drought tolerance			0.867	
Heat tolerance			0.854	
Processing quality			0.652	
Suitability to the environment				0.860
New variety				0.820
Factor mean	6.74	6.94	4.64	6.92
Standard deviation	0.426	0.321	0.762	0.429
Eigenvalue	6.024	2.263	2.005	1.61
Cronbach's alpha	0.837	0.888	0.735	0.615
% variation	33.5	15.1	13.4	10.2
Cumulative percent	33.5	48.6	62.0	72.2

Factor 1 (performance) was comprised of six variables, four of which evaluated the performance of the variety in the field (fast maturing, resistance to disease, vigorous growth and productivity per hectare) and two variables which evaluated the performance of the variety in the market (eating quality and price in the ware market).

Factor 2 (physical characteristics) was comprised of four variables including tuber size, skin colour, flesh colour and tuber shape. Factor 2 was found to be the most important construct influencing the farmer's choice of variety, which suggested a strong commitment towards cultivating those varieties which were perceived to be preferred by consumers.

Conversely, those characteristics which were perceived as being least important included the suitability of the variety for processing, its heat tolerance and drought tolerance (Factor 3). With

regard to the suitability of a variety for processing, all of these variables are interrelated. In the tropics, the majority of varieties used for processing have been found to have much lower specific gravity's, indicative of the higher growing temperatures (Villamayor 1984). High temperatures have also induced the more rapid conversion of starch to reducing sugars, even after only short periods of storage. Furthermore, many varieties, including Atlantic, are susceptible to hollow heart and cracking as a result of inconsistent rainfall and/or irrigation.

Factor 4 (adaptable) evaluates how suitable the variety is to the agro-ecological conditions experienced in-country. The importance of new varieties suggests that farmer's are dissatisfied with the varieties currently available. However, Callueng et al (1993) suggest that this dissatisfaction may arise from the poor quality of the seed. A new variety, especially one that has only recently been imported, is often perceived to be vastly superior, so much so, that for those farmers who are either fortunate enough to be given seed of a new variety, or where they have purchased new seed, they must often conceal it in for field for fear of other farmers stealing the crop as it approaches maturity.

While it was anticipated that the criteria used by farmers to select their most preferred variety may be dependent upon various demographic variables, farm characteristics and the intended market, the only factor to yield any consistent, significant difference was the suitability of the variety for processing (Factor Three). Those farmers who considered the suitability of the variety for processing were generally better educated (attended college or graduated), were active members of a cooperative and regularly attended field days or farmer field schools (Table 5).

**Table 5. Results of cross-tabulations between Factor Three and various demographic variables and on-farm variables.**

	Mean	SD	Sign
Level of education; no secondary	4.689	0.679	0.016
completed secondary	4.578	0.714	0.003
Attended college	5.271	1.056	
Attend field days: yes	5.517	0.753	0.000
No	4.544	0.697	
Member of cooperative: yes	5.267	0.699	0.016
no	4.607	0.754	
Use cut seed: yes	5.081	0.572	0.000
no	4.559	0.765	
Purchase from preferred suppliers; never	4.371	0.824	0.001
sometimes	4.619	0.732	0.011
always	5.086	0.696	

Such farmers were also more likely to purchase seed from preferred suppliers and to use cut seed. Generally, those farmers choosing to grow a crop for processing did not intend to retain any proportion of the harvest for seed to replant any subsequent potato crops.

Despite the increasing demand for processed potato products, it is believed that the major reason for the farmers poor interest in adopting those varieties considered more suitable for processing is the low price most processing companies are willing to pay in comparison to the potential returns farmers can earn from the fresh ware market. Anecdotal evidence from The Philippines suggests that even where farmers have agreed to accept the price a processor is willing to pay before planting, if prices in the ware market increase, farmers will divert produce to the ware market, even where farmers have been provided with the opportunity to direct those tubers which are too large to the ware market or to retain the small tubers for seed. In this regard, farmers will only cultivate a variety for processing if that same variety also proves to be acceptable in the ware market.

### **Conclusions and implications**

Variety and obtaining a source of seed that does not contain a mix of different varieties were found to be the most important variables that influenced a Filipino potato farmer's decision to purchase seed. Such confirms that the selection of the most suitable variety is perceived by Filipino potato farmers to have a profound effect on the productivity and profitability per hectare (HARRDEC 1996). Horton (1987) shows how the productivity per hectare is derived from the correct choice of variety and the use of healthy seed. However, the results suggest that these two variables are interrelated, especially in the developing countries, where, in the absence of a certified seed system, farmer's often retain seed for extended periods of time. Mariano et al (1991) reports that potato farmers in The Philippines have been known to retain seed for up to 12 generations with no apparent reduction in productivity per hectare. While the productivity per hectare is low, such suggests that beyond some threshold level, the desired variety will prove capable of sustaining some minimal level of production. While resistance to disease was found to be an important attribute in the farmer's decision to purchase a particular variety, it is anticipated that the rate at which the seed degenerates will prove to be a more accurate measure of the farmer's decision to purchase a particular variety.

Given the uncertainty of supply in the seed input market, the uncertainty of price in the output market and large seasonal variations in productivity (Crissman and Hibon 1996), Filipino potato farmers are expected to adopt various mechanisms to reduce their exposure to risk. One of the strategies generally adopted is to purchase seed from those seed suppliers who have supplied the farmer in the past and to purchase seed of those varieties which have produced satisfactory results. While the farmer's preference for a particular variety is expected to provide a significant barrier towards the adoption of other less well or unknown varieties, the lack of sufficient quantities of good quality seed may entice farmers to investigate alternative varieties (Callueng et al 1993).

Even so, while productivity per hectare is customarily measured by the physical weight of the tubers harvested, potato farmers, traders, processors and consumers will be more concerned about the size of tubers harvested and tuber quality, for the profitability of cultivating potatoes is determined not only by the productivity per hectare, but the average prices received per unit weight. The price potatoes command in the ware market will depend upon their physical attributes (skin colour, flesh colour, dry matter content, taste, texture and any signs of damage caused by pests and diseases or mishandling), how they will be used, local tastes and preferences and the local market conditions (Horton 1987). For this reason, the physical attributes of the variety (Factor One) were found to be particularly important in influencing the farmer's choice of variety. These characteristics, however, may differ from market to market,

for consumer preferences for the type and quality of potato required can vary greatly among locations and even within a location.

While the quality of the tubers required by potato processors seems more consistent and thus there is a demand for the same varieties worldwide, the adoption of these processing varieties in The Philippines seems largely dependent upon the acceptance of the variety in the ware market. Despite the presence of supply contracts, the majority of potato farmers seem intent upon engaging in opportunistic market practices. However, the better, more educated farmers seem more likely to adopt processing varieties, presumably because they recognize and value the security that a supply contract provides. Nevertheless, there is evidence to suggest that these farmers attempt to minimise costs and maximise output by using cut seed. While this technique has been used extensively in the past, it is no longer recommended because of the very high incidence of bacterial wilt in the highlands. For those farmers growing process potatoes, the majority indicate that they do not intend to retain any proportion of the crop for seed. Furthermore, anecdotal evidence suggests that farmers cut the seed because of the very high price of the seed, relative to that grown for ware potato crops.

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