BIBLIOGRAPHY

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ABSTRACT

The chipping quality of nine potato accessions grown organically in different production sites of Benguet was evaluated. The study aimed to determine the influence of different production sites on the chipping quality of potato accessions grown organically, identify the potato accession with the best chipping quality, and determine the interaction between the production site and potato accession on chipping quality.

Potatoes grown in Balili, La Trinidad (1,336 m asl; 18.36^0C; 71.81% RH) had relatively high yields and consistently produced tubers with good chip quality. Furthermore, the harvested potatoes had high dry matter content (20.78%), specific gravity (1.077), and chip recovery (82.74%). The potatoes also had one of the lowest sugar content (3.94^0Brix), thus, producing light yellow chips with no browning. The chips were also liked much by the panelists.

Potatoes harvested from Longlong (1,342 m asl; 20.49^0C; 80.81% RH) and Cabutotan (1,588 m asl; 16.19^0C; 87.50% RH) also yielded well with a good chipping quality and high chip recovery. Moreover, the chips produced were light yellow but were liked moderately by panelists.

Accession 13.1.1 and 5.19.2.2 had the highest dry matter contents (20.03% and 20.47%), specific gravity measurements (1.074 and 1.084), and percent chip recovery (78.07 and 77.57). Also, they had the lowest sugar contents (3.88^{0}Brix and 3.91^{0}Brix), thus, producing the desired light yellow chips with no browning.

Production site and potato accession interacted significantly to affect dry matter content, sugar content, chip recovery, chip color, and specific gravity. This interaction means that both site and accession are important considerations in organic growing of potatoes for chipping.

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INTRODUCTION

Background of the Study

Potato varieties with high yield and acceptable processing quality are vital requisites in our local processing industries. However, varieties with such characteristics are limited. Only a few processing varieties such as Igorota, Kennebec, Atlantic, and Columbus are grown in the highlands. Thus, there is an increasing need to continuously evaluate more varieties or accessions that have good processing qualities.

One of the processed products set for commercial production is the potato chip. The chips first appeared during the mid 1850's as a normal part of American cooking. The potato was most likely sliced from the axis of the tuber and then fried. It was only until a certain chef named George Crum sliced the tubers thin enough to become crunchy potato chips. The chips, originally called 'potato crunches' became popular in restaurants and grocery stores. They were eventually introduced to England and neighboring countries during the early to mid part of the 20th century (Harmon, 1998).

The potato chip industry continues to grow in countries worldwide including the Philippines. In fact, 400 to 533 metric tons of fresh potato tubers must be supplied merely for potato chip processing (Department of Agriculture *et al.*, undated). However, with the reported Philippine production of 68,000 metric tons (FAO, 2002), only a portion of it is usually suitable for processing. The Philippine government thus imports processed potatoes, which in 2001 were valued at $16,858,000.00 (Gagnon, 2002).

Importance of the Study

Potato processors use whatever is available to them at the time of processing. Some processors use a mixture of potato varieties which are both imported and locally produced. As a result, the quality of potato chips is greatly affected. For instance, potato varieties with high sugar content produce brown chips with bitter taste. Other varieties with low dry matter content produce soggy potato chips with high oil uptake and longer frying time.

Furthermore, two large-scale potato processors in Metro Manila mainly procure the Granola variety because it is readily available but not ideal for processing. It has low dry matter, high moisture content, and produces chips that easily brown during frying (FRLD, 1995)

Potatoes are mainly grown conventionally with the application of expensive chemicals and other synthetic compounds. When chipped, these potatoes were found to contain as high as 73% pesticide residue (Lang, 2005). Growing processing type potatoes organically is therefore a better alternative to conventional production methods. It is in fact claimed that organically grown potatoes taste better and contain more dry matter than conventionally-grown ones

(Finesilver, 1980). Health wise, organically grown potatoes are safe foods that are free from toxic and harmful chemicals.

The location of production areas and the employed cultivation practices also influence important quality factors of potato tubers for processing such as specific gravity, dry matter, sugar content, and others. Thus, it is necessary to grow potatoes in several locations to evaluate processing quality of different accessions.

Several studies have been conducted to evaluate the suitability of potato varieties to chipping. However, the varieties identified for processing are limited and often susceptible to diseases.

It is therefore important not only to identify an appropriate potato accession that can give good quality chips but also determine the effect of location of production to potato chip quality.

Objectives of the Study

The objectives of this study were to:

1. determine the effect of different production sites on the chipping quality of potato accessions grown organically;

2. identify the potato accession grown organically with the best chipping quality across production sites; and

3. determine the interaction of the potato accessions and different production sites on chipping quality.

Time and Place of the Study

The study was conducted at Englandad, Sinipsip, Loo, Balili, Longlong, and Cabutotan where the potatoes were organically grown. The harvested potatoes were processed at the College of Agriculture Complex, Benguet State University, La Trinidad.

The study was conducted from October 2005 to March 2006.

REVIEW OF LITERATURE

Origin and Distribution of Potato Chips

Piecing together how chips spread between 1853 and the early part of the 20th century is difficult. It is, however, assumed that the potato chips first appeared in 1853 at Saratoga Springs, New York, which is considered its place of origin. A certain cook named George Crum sliced the tubers very thinly to produce crispy potato chips. The potato chips were then introduced to England in 1921 (Harmon, 1998) and eventually to other parts of the world.

The Potato Chip Industry

The potato chip industry has a demand for fresh potato up to 533 MT daily. However, this demand for potatoes intended for processing is not met by local production in volume and quality (HARRDEC, 1998).

Baguio and Benguet are the primary suppliers of potatoes for chips in the Philippines. A newly emerging supplier is Mindanao. Metro Manila has been absorbing about 50% of the potato chips. However, sales of potato chips in the Philippines declined from 14% in 1990 to 6% in 1992 (Dep't of Agriculture, undated).

Suitability of Potato Varieties for Chipping

Production and yield. Planting area and production of processing are very limited. The main reasons are lack of suitable varieties for processing, little access of potato farmers to these varieties, limited knowledge of industries on the standards and requirements of processing potatoes, and susceptibility of processing varieties to pest and diseases (Kaiyun *et al.*, 2004).

High tuber yields and quality are also important determinants for the suitability of a given variety for large-scale local production. Varieties with higher specific gravity and dry matter tend to have higher yields and better quality of finished chips. Moreover, color of chips depends on sugar content of tubers (Tawfik *et al.*, 2002).

Well-adapted potato cultivars that require fewer days to produce high marketable yields would be specifically advantageous in much of the East. Unlike most western production areas, short seasons (90-110 days) prevail in much of the East, especially in northern areas. Early-maturing cultivars would also be useful in intensively managed systems (e.g. organic, hoop houses, etc), especially if access to the earliest markets and/or escape from persistent disease and insect pressure (NERA, 2002).

Available varieties. Choosing varieties is very important for chip processing, however, small-scale producers use varieties that are available to them at the time of processing. As a result, the quality of chips varies tremendously, as the processing quality is a function of both physical and chemical factors of the tubers (Illeperuma and Wickramasinghe, 2000).

Moreover, potato varieties for processing suffer from poor varietal improvement (Dep't of Agriculture, undated). Locally grown potato varieties in the country have very low dry matter content (15% to 18%) which is not suitable for processing. The development of suitable varieties (i.e. adapted to the local growing conditions and acceptable to processors and consumers) is therefore very necessary not only to help local farmers but also to develop the country's potato processing industry (HARRDEC, 1998).

Several potato varieties have been identified to be adaptable to the country's agro-climatic conditions such as the *Chipeta* and *Atlantic* for chips, and the *Kennebec* and *Century Russet* for both chips and fries. These varieties are now being tested in various experimental farms in the Cordillera and in the growing areas of Mindanao (Department of Agriculture, undated).

Dry matter content and specific gravity. Potato varieties with high dry matter content are considered suitable for chips as the dry matter content is associated with mealiness, crispness, and reduced oil uptake in the fried chips (Illeperuma and Wickramasinghe, 2000).

Potato varieties for chipping has to have high dry matter content (19% and above). High dry matter content gives high chip yield with low fat content.

Further, to obtain light colored chips, the reducing sugar content should be less than 0.2% (NPRCRTC, undated).

For the production of potato chips, varieties with dry matter content of 22-24% are required. The content of reducing sugars in the potato is also a determining factor with respect to the suitability of a potato variety for processing. Usually, the lower the reducing sugar content, the better the quality of the product. Potato varieties with 0.2% reducing sugar are acceptable for chips (Coumou, 1991).

The specific gravity or the dry matter content of potatoes are important because it influences the uptake of fat or oil during frying. Higher yield of processed products and lower oil uptake is a result of potatoes with high specific gravity (Verma, 1991).

High specific gravity is particularly important in the production of potato varieties for chips because of greater surface area to volume ratio in chips. Moreover, chip crispiness and lack of oiliness increases with increasing specific gravity (Scanlon, 2006).

Sugar content. Processors prefer varieties that are best suited to produce light colored chips. However, maintenance of the desired color is the major problem associated with the chipping industry. The varieties used have inherent differences with respect to their chip color. These varieties contain different levels of reducing sugar, which are used to predict the suitability of potato tubers for chip processing, as they are often responsible for color development (Illeperuma and Wickramasinghe, 2000).

A reducing sugar content of 0.25 to 0.30 mg-g^sup-1^ fresh weight or 0.025% to 0.030% on fresh weight basis is the maximum concentration allowed in tubers used for chips (Oltmans and Novy, 2002).

Potatoes destined for making chips, French fries and other fried products, need to have low sugar content to avoid browning of the finished product. The sugar content of potatoes is determined by the genotype and several pre and post-harvest factors (Kumar *et al.*, 2004).

Morphological characters. Potato chipping varieties should have round and uniform tuber shape, light brown tuber skin color, shallow eye depth, and free from defects. Moreover, these varieties must have low reducing sugar ($\leq$ 0.2%) and moderate dry matter content (20-25%) (Kaiyun, 2004).

Large round tubers are preferred by the chipper, since their size and shape facilitate the removal of the peel more efficiently and with less solid loss. Further, cultivars with shallow eyes and few in number are to be preferred. If the eyes are deep, it is necessary to peel for longer periods of time to remove the eye. Potato varieties with high specific gravity are also preferred because they have been shown to absorb less cooking oil during the chipping process (Gould, 1988).

Potato Chip Quality

Good quality potato chips have a light color with little vascular discoloration. The color of potato chips depends on the reducing sugar content of the potatoes. Potato chips must also have a pleasing and desirable flavor, thus potatoes used in chipping must not be bitter or have other off-flavors. The flavor of potato chips is more complex than that of boiled, baked or mashed potatoes, since the cooking temperatures are higher, and the absorbed oil contributes to the overall flavor profile of the product (Scanlon, 2006).

An important factor influencing potato chip color is the level of reducing sugars, glucose and fructose, at the time of frying. Glucose and fructose are the products of sucrose hydrolysis mediated by the enzyme invertase. Increasing concentrations of reducing sugars in the tuber correlate with darker chip color (Oltmans and Novy, 2002).

Chipping quality is a genetically transmissible character. Potatoes that produced light-colored chips after cold storage and reconditioning were shown to transmit the ability to produce light-colored chips to their progenies (Oltmans and Novy, 2002).

Many factors contribute to potato chip quality. This includes maturity of tuber, shape, thickness, skin, peel, eyes, skin and flesh color, defects, specific gravity, temperature, reducing sugar and sucrose content, and chipability. Chip manufacturing procedures, such as peeling, slice thickness and uniformity, oil type and temperature and packaging methods and materials all have a direct impact on potato chip quality (Ohio State University, 2002).

The quality of chips is determined by appearance, color, taste/ flavor, texture, moisture content, oil content and nutritional value. Color is by far the most important quality characteristic followed by oil content (Hesen, 1991).

Influence of Production Site to Processing Quality of Potatoes

Experiments have shown a high effect of the factor “site” on the suitability for processing of different potato varieties in organic farming. The results of these experiments confirm the influence of site of production on the quality of potatoes for processing (FAL, 2005).

The sugar content of potatoes is affected by the climatic factors in a location, such as temperature during growth, minimal nutrition, and irrigation (Kumar *et al.*, 2004).

The amount of sucrose found in potatoes at harvest is influenced by planting date, growing location, soil fertility, water availability, and any stress-inducing event (Campbell and Bagley, 2006).

Specific gravity of tubers is influenced by the cultural management of farmers in a location. Specific gravity generally decreases with reduced water application and increased available nitrogen (Ojala *et al*, 1990).

The variation in specific gravity, yield and percent yield of large size tubers may be caused by cultivation practice, climatic condition, time of planting and harvesting, location, etc. Hence, it is necessary to grow the selected clones at several locations for further evaluation of processing quality, specific gravity, yield, and percent yield of large size tubers (Tantidham *et al.*, 1991).

Both the specific gravity and the dry matter content varied with the variety and the location of production. Such variation has been reported for many varieties grown in other countries (Verma, 1991).

Organic Farming in Potatoes

Varietal selection. In selecting varieties for organic potato production, varieties suited to organic production and those which best suit the intended market should be selected and grown (Dep't of Agriculture for Northern Ireland, 1996).

Crop rotation. Potato plants are easy to grow, but they aren't the easiest to grow using organic methods. Potatoes are prone to quite a few insect pests and diseases that can be a challenge to manage organically (Grubinger, 2005). Thus, organic potatoes must be a part of an overall rotation. This will involve building up of soil fertility and then exploiting that fertility with a nutrient-demanding crop such as potatoes. Legumes must be included in the rotation to provide nitrogen.

Without adequate nitrogen being available, the potato crop will yield very poorly (Walsh, 2001).

Fertilizer application. Potato growth depends on a supply of plant nutrients, such as nitrogen, phosphorus, and potassium. Each of these nutrients has specific functions for the growth and development of potato plants (Vander Zaag, 1981). Based on the results of some studies, combined potassium (K) and organic nitrogen (N) was found to be the most efficient fertilizer to increase yield for crisp and french fry production (Haase, 2005).

Quality of Organically Grown Potatoes

Organically grown foods provide more nutrients than conventionally grown foods. A recent study conducted by the Organic Center for Education and Promotion found that organically grown foods contained on average 30% more antioxidants than their conventional counterparts. A higher intake of antioxidants has been shown to have a protective effect against development of cancer, coronary heart disease, and cataracts (Lang, 2005).

In addition, glycoalkaloids (natural protective agents in potato plants and tubers) and levels of potassium, magnesium, phosphorus, and sulfur were found to be higher in organic potatoes (Martin, 2005). Vitamin C may be higher as well in organically grown produce (Finesilver, 1989).

Organically grown food also has higher dry matter content with a small number of results showing them to be lower (Finesilver, 1989).

In terms of taste, potatoes grown organically obtained significantly higher mean taste scores than conventionally grown after 6 months storage when tested blindly by a panel (Finesilver, 1989). This difference may be explained by the presence of glycoalkaloids which are higher in organic potatoes. Glycoalkaloids are thought to move from outer (such as skin) to inner (such as flesh) layers of potatoes during boiling and responsible for the perceived flavor differences (Martin, 2005).

Comparison between Conventional and Organically Grown Potatoes

Fertilizer application. Conventional fertilizing practices such as increased application of synthetic N fertilizers may possibly result in higher crude protein concentration in plant foods but poorer quality protein than organic practices (Finesilver, 1989).

Pesticide residue. Organically grown foods have fewer pesticide residues than conventionally grown foods. Pesticide residues were found on 23% of organic foods and 73% of conventional foods. When incidences of DDT and other banned pesticides were removed, the incidence on organically grown foods fell to 13%, but only to 71% on the conventional crops. This result indicates that roughly half of the incidence of residue found on organically grown foods is due to the persistence of past pesticide use. The incidences of residue found on conventionally grown produce were due to current applications (Lang, 2005).

Yield. Yields on organic farms are found to be lower than yields on conventional farms, in large part because of damage by insects and diseases, but profits are higher because organic potato prices are higher than conventional prices. However, even with the price premium, good organic growing practices are needed in order to assure decent marketable yields (Grubinger, 2005).

Organically grown products are on the average 57% more expensive than conventionally grown ones. However, the higher cost is balanced by the benefits of organically grown foods (Lang, 2005).

Statistical Tool Used to Analyze Sensory Evaluation of Processed Products

Data of sensory evaluation for chips and French fries were statistically analyzed using a General Linear Model (GLM) procedure of SAS Institute. Least Significant Difference (LSD) at $P \leq 0.05$ was used to separate treatment means (Tawfik *et al.*, 2002).

Computation of data for chip color was carried out using the multiple linear regression analysis program (32 regression). The results of this computation (coefficient of multiple correlation and regression equation) indicate that these equations provide reasonably good prediction of the chip color of individual potato cultivars (Mazza, 1983).

MATERIALS AND METHODS

Nine potato accessions obtained from Northern Philippine Root Crop Research and Training Center (NPRCRTC) were planted in different production sites of Benguet and their tubers were processed as chips.

The treatments of the study replicated three times were:

Factor A: Production Sites (PS)

	Place	Elevation
PS 1	Englandad, Atok	2, 300 m
PS 2	Longlong, La Trinidad	1, 342 m
PS 3	Sinipsip, Buguias	2, 350 m
PS 4	Loo, Buguias	1, 638 m
PS 5	Balili, La Trinidad	1, 336 m
PS 6	Cabutotan, Madaymen	1, 588 m

Factor B: Potato Accessions (NOP)

	Agency Code
NOP 1	380251.17
NOP 2	676070
NOP 3	Ganza
NOP 4	285411.22
NOP 5	573275

NOP 6	676089
NOP 7	5.19.2.2
NOP 8	575003
NOP 9	13.1.1

Experiment 1: Field evaluation of potato accessions in different production sites

Nine potato accessions were planted in six organic farms of Benguet. Rooted stem cuttings were used in all sites. The cuttings were planted in 1m x 5 m beds at 30 cm between hills and rows in all sites except Longlong. The cuttings were instead planted in plastic pots situated in partially shaded plastic houses.

Cultural management practices for organic production such as multiple cropping, use of yellow traps, planting of repellant crops, and others were followed in each site.

The potato accessions were then harvested and samples of mature and sound potato tubers were obtained from the different sites.

The treatments in each site were laid out following randomized complete block design (RCBD).

The data gathered were:

1. Organic production practices of farmers. The farmers from each location were interviewed using a prepared questionnaire to determine their specific organic production practices that might affect chip quality.

2. Site description. The relative humidity, temperature, soil properties, and elevation of the different production sites were taken.

3. Total yield/ accession (g/ plant). This was obtained by taking the total weight of tubers from each treatment at harvest.

Experiment 2: Processing quality of potato accessions grown in different production sites

Medium to large-sized potato tubers were weighed at 100 g per replication per treatment. The tubers were then hand peeled, sliced into approximately 1 mm thickness using a chipper and washed thoroughly with water (Plate 1). To reduce oil absorption, the chips were drained on a cotton cloth. The potato chips were deep-fried in vegetable oil and drained when bubbling of oil stopped and were packed and sealed in polyethylene bags for sensory evaluation by ten non-smoking panelists.

The treatments were laid out using the 9 x 6 factor factorial in randomized complete block design (RCBD) with three replications.

a. Chipping of potato tubers

b. Drying of potato chips

c. Frying of potato chips

d. Packing of potato chips for sensory evaluation

Plate 1. Chipping of the different potato accessions

The data gathered were:

1. Tuber characteristics. The shape, peel color, peel texture, flesh color, eye depth, and other characters were taken using the following scales (CIP, 1977):

a. Tuber skin color.

Rate	Description
0	White-cream
1	Yellow
2	Orange
3	Brownish
4	Pink
5	Red
6	Purplish-red
7	Purple
8	Dark purple-black

b. Tuber skin type

Rate	Description
0	Smooth
1	Rough (Flaky)
2	Partially netted
3	Totally netted
4	Very heavily netted

c. Tuber flesh color.

Rate	Description
0	White
1	Cream
2	Pale yellow
3	Yellow
4	Deep Yellow
5	Red
6	Violet
7	Purple

d. General tuber shape

Rate	Description
0	Compressed
1	Round
2	Ovate
3	Obovate
4	Elliptic
5	Oblong
6	Long-oblong
7	Elongate

e. Depth of tuber eyes

Rate	Description
0	Protruding
1	Shallow
2	Medium
3	Deep
4	Very deep

2. Dry matter content (%). Twenty gram samples of potato tubers were sliced into cubes, weighed, and ovendried (Memmert D-91126 Schwabach) at 80^0C for 24 hours. The dry matter content was then be computed using the formula:

Dry matter content = 100% - % Moisture content

Where:

$$\% \text{ Moisture content} = \frac{\text{Fresh weight} - \text{Ovendry weight}}{\text{Fresh weight}} \times 100$$

3. Specific gravity. The dry matter content of the tubers was converted into specific gravity measurement using a table of equivalents (Kellock, 1995).

4. Sugar content (^{0}Brix). Juice was extracted from grated potato tubers. The sugar content from the extracted juice was then taken using a digital refractometer (Atago USA, Inc.).

5. Chip recovery (%). The weight of unpeeled and chipped tubers was taken and chip recovery was computed using the formula:

$$\text{Chip recovery} = \frac{\text{Weight of unpeeled tubers} - \text{Weight of chipped potatoes}}{\text{Weight of unpeeled tubers}} \times 100$$

6. Chip color. Potato chip color was determined using the Potato Chip Color Reference Standard prepared by the Potato Chip Institute International (undated).

7. Chip browning. The browning of the chips was evaluated using the following scale:

Scale	Description
1	No browning
2	Slight browning
3	Moderate browning
4	Severe browning

8. Sensory evaluation. The crispiness, flavor, texture, oiliness, appearance, and general acceptability of the potato chips were evaluated by ten panelists using the following rating scales:

a. Crispiness (Jose, 1998)

Scale	Description	Remarks
1	Very easy to crumble	Very crispy
2	Easy to crumble	Crispy

3	Crumbled without difficulty	Moderately crispy
4	Crumbled with difficulty	Slightly crispy
5	Hard to crumble	Not crispy

b. Flavor (Jose, 1998)

Scale	Remarks	Description
1	Very strong flavor	Very perceptible
2	Strong flavor	Perceptible
3	Little flavor	Moderately perceptible
4	Very little flavor	Slightly perceptible
5	No flavor	Not perceptible

c. Texture (Jose, 1998)

Scale	Description
1	Firm
2	Moderately Firm
3	Slightly Firm
4	Not Firm

d. Oiliness

Scale	Description
1	Very oily
2	Oily
3	Moderately oily

4	Slightly oily
5	Not oily

e. Appearance

Scale	Description
1	Like very much
2	Like much
3	Like moderately
4	Like slightly
5	Not like/ Dislike

f. General acceptability

Scale	Description
5	Like very much
6	Like much
7	Like moderately
8	Like slightly
9	Not like/ Dislike

The data was analyzed through Analysis of Variance using the 9 x 6 factor factorial in RCBD across sites. The significance among treatment means was analyzed using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Experiment 1: Field Evaluation of Potato accessions in Different Production Sites

Cultural Management Practices for Organic Potato Production in the Different Production Sites

Applying the appropriate cultural management practices in growing potatoes for processing is important. Such practices could affect chip quality (Table 1).

Englandad, Atok

Description of the farm. The farm is located at 2,300 m asl on a plateau. It has been cultivated organically for four years and previously planted with vegetables such as carrot, broccoli, cabbage, etc. Calla lily is also planted as borders and windbreakers.

Cropping pattern. Rotation of carrot (or cabbage, Chinese cabbage, etc.), potato, and carrot is a common practice in the farm. Oftentimes, potato is also planted at the same time with other crops such as brocolli. Garden pea, pechay, or sweetpotato is planted on the borders of the farm.

Land preparation. The common practices such as cleaning, digging, and making of raised beds are done with the use of grab hoe and sharp wooden stick. Before sowing, the soil is pulverized for more efficient root growth.

Table 1. Cultural management practices of the farmers in the different production sites

STAGE	ENGLANDAD	LONGLONG	SINIPSIP	LOO	BALILI	CABUTO-TAN
LAND PREPARATION						
Activities	Weeding, digging	Not applicable	Weeds plowed under	Weeding, digging	Weeding, digging	Weeding, digging
Implements	Grab hoe, sharp wooden stick	Japanese hoe	Grab hoe	Japanese hoe	Grab hoe	Grab hoe, Japanese hoe
Beds	Raised	Plastic pots	Raised	Raised	Raised	Raised
Medium	Soil	2:1 garden soil and compost	Soil	Soil	Soil	Soil
PLANTING MODE	Direct	Transplant	Direct	Direct	Direct	Direct
FERTILIZATION						
Type	Compost	Compost and Green manure	Compost	Compost	BSU Compost and Growth enhancer (plant extracts)	Organic fertilizer (Galactic), chicken dung, green manure

Table 1. continued…

STAGE	ENGLANDAD	LONGLONG	SINIPSIP	LOO	BALILI	CABUTO-TAN
Application	Basal and side dress	Basal	Basal and sidedress	Basal	Basal	Basal and sidedress
Composition of compost	Chicken dung, sunflower, pig manure, crop residues, garden soil	Shredded grasses, effective microorga-nism (EM)	Chicken dung, sunflower, available weeds	Corn stalks and leaves, chicken dung, yeast, grasses, raw sugar	Chicken dung, grasses, microorganism	Rice bran, soil, indigenous effective microorga-nism, chicken dung
Composition of green manure	Not applicable	Available weeds in farm	Weeds	Grasses and plant stubble	Not applicable	Weeds
IRRIGATION	Overhead	Sprinkler	Rain-fed	Overhead	Overhead	Overhead
PEST MANAGEMENT						
Cultural control	Rouging, planting of repellant plants	Multiple cropping	Rouging	Multiple cropping	Mixed cropping, planting of repellant plants	Irrigation

Table 1. continued…

STAGE	ENGLANDAD	LONGLONG	SINIPSIP	LOO	BALILI	CABUTO-TAN
Chemical control	Biofungicide (*Bacillus subtilis*)	*Bacillus thuringiensis*	Biofungi-cide (*Bacillus subtilis*)	Garlic and marigold extracts	Biofungicide (*Bacillus subtilis*)	Biofungicide (*Bacillus subtilis*) + baking soda + Joy® + Oriental herb nutrient (OHN)
Physical control	Hand picking	Not applicable	Hand picking, sack barriers	Sack barriers	Yellow traps	Hand picking
BASES FOR SEED SELECTION						
Disease/ Pest reaction	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
Yield	High	High	High	High	High	High
Adaptability	Local conditions	----	Frost and cold	----	----	Local conditions
Other Characters	----	Peel color for customer preference	----	Large tubers and field storability	Tubers for chips	Large tubers and early maturing

Planting. Seeds or stem cuttings are planted directly in plots that have been previously watered.

Fertilizer application. Compost consisting of chicken dung, sunflower, pig manure, crop residues, and soil is prepared by the farmer before land preparation. The compost is applied basally one to two weeks before planting and side-dressed during hilling up one month after planting.

Irrigation. Watering of plants is done one to two times a week using watering cans.

Pest management. Diseases such as late blight are controlled by the farmer through removal of diseased plant parts or rouging and use of a bio-fungicide (*Bacillus subtilis*). Insects are controlled by hand picking and planting of repellant crops (calla lily).

Seed selection. The farmer prefers potato varieties which are resistant to pest, high yielding, and adapted to local conditions.

Longlong, La Trinidad

Description of the farm. The farm is situated on a terraced area that is 1,342 m asl. The area that is devoted to organic production for more or less six years is 1,500 m^2 wide.

The crops, mostly vegetables and spices, are planted on beds bordered by bricks that have been cemented in place. This practice of cementing the sides of the beds will better conserve soil nutrients. The beds are partially shaded by plastic roofing.

Cropping pattern. Multiple cropping of vegetables (e.g lettuce, broccoli), herbs (e.g. rosemary), sugar beet, and potato is practiced to encourage diversity in the farm.

Land preparation. The farmer plows the soil 12 inches deep using Japanese hoe.

No land preparation was done for the potatoes since black plastic pots were used and placed in between the beds.

Planting. For other vegetables, the farmer sows seeds in small plastic trays then finally transplants the seedlings to the beds.

The rooted stem cuttings of potato were directly planted on the plastic pots.

Fertilization. The farmer prepares his compost. The compost consists of shredded grasses, collected from the farm, that are composted within 14 days with the aid of an effective microorganism (EM) solution. One part compost and two parts garden soil are mixed and placed in plastic pots prior to planting of potatoes.

Green manure is also added by the farmer twice during plant growth until the pots are filled.

Irrigation. Water is applied to the plants using sprinklers.

Pest management. The farmer controls pests through multiple cropping, crop rotation, and use of microorganisms (*Bacillus thuringensis*).

Seed selection. The farmer prefers potato varieties which are resistant to pest and diseases, high yielding, and produce tubers with unique skin color to attract consumers.

Sinipsip, Buguias

Description of the farm. The farm has been cultivated organically for five years. It is located on a terraced area that is several hundred meters away from the main highway. The elevation of the farm is 2,350 m asl.

Highland vegetables such as carrots and Chinese cabbage are commonly planted in the farm. The farm is also surrounded by a fence made of straw sacks to prevent very strong winds from damaging the crops.

Cropping pattern. Prior to potatoes, the farm was planted with carrots and radish. After potatoes, cabbage or Chinese cabbage is planted. At times, the vegetables are also planted at the same time with potato.

Land preparation. Digging, making of raised beds, and pulverizing using grab hoe are the common practices of the farmer. Weeds are plowed under to serve as green manure.

Planting. Seeds or seedlings are directly sown on raised beds.

Fertilization. Basal and side-dress application of compost is the customary practice. The compost prepared by the farmer consists of chicken dung, sunflower, and other weeds. Green manure is also incorporated in the soil during land preparation.

Irrigation. The farm is rain-fed.

Pest management. Pests are controlled through hand picking, rouging, and using of yellow traps and a bio-fungicide (*Bacillus subtilis*). Straw sacks that serve as barriers to wind and indirectly to pests, surround the farm.

Seed selection. The farmer selects potato varieties based on resistance to pest, high yield, and tolerance to frost and cold.

Loo, Buguias

Description of the farm. The farm is located on a plain area with an elevation of 1,638 m asl. It transitioned into an organic farm four years ago. The crops commonly planted in the farm are highland vegetables and fruits.

Cropping pattern. Rotation of lettuce or carrots, potato, and broccoli and/ or lettuce is done in the farm.

Land preparation. Similar to the other sites, weeding, digging, and making of raised beds using Japanese hoe are done. The soil is also pulverized before planting. If the soil is too compact, the farmer irrigates the field before digging.

Planting. Seeds are directly planted on raised beds.

Fertilization. Compost consisting of corn stalk and leaves, chicken dung, yeast, grasses, and raw sugar is applied basally with no side-dress application.

In addition, grasses and plant stubble are incorporated after harvest to serve as green manure for the next crop.

Irrigation. Plants are watered regularly from a natural spring. The water is brought to the field through a rubber hose.

Pest management. Insect pests and diseases are minimized through multiple cropping, crop rotation, and use of a botanical pesticide made of garlic and marigold extract.

Seed selection. The farmer prefers potato varieties that are resistant to pest and high yielding with large tubers. In addition, the tubers must also be adapted to delayed harvesting with no or minimal decrease in quality.

Balili, La Trinidad

Description of the farm. The farm is located on a slightly sloping area with an elevation of 1,336 m asl. The area has been devoted to organic farming for more than three years.

Practices other than the use of pesticides and synthetic fertilizers are employed to preserve the quality of the soil at the same time minimize pest.

Cropping pattern. Rotation of beans, potato, and beans is practiced. The land is fallowed for at least three months before beginning another rotation of crops. Corn is planted on the borders of the farm to serve as barriers while marigold is planted in between beds to serve as repellant against insects.

Land preparation. The area is first cleared of weeds and then dug and the soil is pulverized. The beds are raised for more efficient sowing.

Planting. Commonly, seeds are directly sown on plots.

Fertilization. Basal application of BSU compost is the common practice. A growth enhancer made of plant extracts is also applied to the soil one month after planting.

Irrigation. Water is applied twice a week using watering cans.

Pest management. Pests and diseases are controlled through the integration of mixed cropping, planting of repellant crops such as marigold, use of yellow traps, and applying a bio-fungicide (*Bacillus subtilis*).

Seed selection. Potato varieties with high yield and resistance to pest and diseases are preferred. Another basis of selection by the farmer is suitability to processing.

Cabutotan, Bakun

Description of the farm. The farm has been devoted to organic production for two years. It is located on a sloping area with an elevation of 1,588 m asl.

The farm is planted with different kinds of vegetables, spices, and root crops. The farm is also bordered by a black net which serves as a barrier.

Cropping pattern. Potato, cabbage, and potato or carrots or radish are planted in rotation on the farm. The area is divided into lots where the crops are rotated after each cropping season. Root crops such as sweetpotato border the farm.

Land preparation. The farm is cleared of weeds before digging. It is cultivated using grab hoe and Japanese hoe. Plots are made and oriented parallel to the slope of the land to prevent soil erosion and surface run off.

Planting. Direct planting of seeds or stem cutting is commonly practiced.

Fertilization. A combination of an organic fertilizer (Galactic), chicken dung, and several weeds are applied basally to the soil. Based on the product information, the organic fertilizer (Galactic) consists of rice bran, soil, indigenous effective microorganism, and chicken dung.

Irrigation. Water is applied through overhead method using rubber hose.

Pest management. Pests are controlled through controlled irrigation, handpicking, and spraying of a mixture of a bio-fungicide (*Bacillus subtilis*), baking soda, Joy®, and an oriental herb nutrient (OHN). The mixture is prepared by the farmer and sprayed on the plants to prevent or minimize disease incidence.

Seed selection. The farmer prefers potato varieties that are resistant to pest, high yielding, early maturing, and adaptable to local conditions. Potato varieties that can produce large tubers are also selected.

Temperature and Relative Humidity
in the Different Production Sites

Potatoes grow best in sites with a temperature range of 15^0C to 22^0C (Sano, no date). Almost all sites are within the optimum temperature range except Sinipsip (Table 2).

Table 2. Average temperature and relative humidity of the different production sites (October to March)

	ENGLAN-DAD	LONG-LONG	SINIP-SIP	LOO	BALILI	CABUTO-TAN
Temperature (^{0}C)	16.48	20.49	12.76	17.74	18.36	16.19
Relative Humidity (%)	87.67	80.81	92.88	75.25	79.81	87.50

Thus, potatoes may be produced successfully in any of the sites except Sinipsip. Otherwise potatoes may be planted during the months of the year where temperature may increase at Sinipsip.

Potatoes also grow successfully in sites with an average relative humidity of 86% (Sano, undated). Sinipsip has a relative humidity which is too high. The weather at the site was continually wet and cloudy which might greatly affect potato yield and quality (Beukema and Van der Zaag, 1979). The rest of the sites have relative humidities within the range of the optimum relative humidity for successful potato production.

Sugar and dry matter content which are critical quality factors for processing potatoes are often affected by environmental factors in the production site. High temperatures directly affect tuber physiology and inhibit starch deposition. Also, low relative humidity, high solar radiation, and high wind speed can reduce photosynthesis thereby reducing dry matter content and increasing sugar content. Prolonged periods with overcast skies can reduce light intensity to levels below that required for maximum dry matter production (Stark *et al.*, 2003).

Soil Properties in the Different Production Sites

Englandad, Atok

The soil pH decreased from 6.34 to 6.23 after harvest (Table 3). The decrease in soil pH may have been effected by several factors such as high rainfall, cold and humid climate, accumulation of soil organic matter, production and removal of heavy harvest, etc (Singer and Munns, 2002). Englandad had relatively low temperature (16.48^{0}C) and high relative humidity (87.67%) which might have contributed to the decrease in soil pH even with the application of compost.

Table 3. Soil properties of the different production sites

	ENGLAN-DAD	LONG-LONG	SINIP-SIP	LOO	BALILI	CABUTO-TAN
Before planting						
PH	6.34	6.64	6.23	6.50	6.69	6.25
OM (%)	4.50	17.50	7.00	2.00	3.50	3.00
N (%)	0.22	0.88	0.35	0.10	0.18	0.15
P (ppm)	395	75	360	400	160	5.00
K (ppm)	676	2,960	136	1,570	274	102
After harvesting						
pH	6.23	6.76	6.47	6.51	7.02	5.96
OM (%)	4.00	6.00	10.00	2.50	3.00	2.50
N (%)	0.20	0.30	0.50	0.12	0.15	0.12
P (ppm)	405	360	315	270	160	7.00
K (ppm)	752	3,000	572	660	948	124

Soil pH may indirectly affect the processing quality of a potato tuber. The release of nutrients in the soil is affected by pH. Soils with very low pH, for instance, may make essential nutrients unavailable to plants. As a result, plant growth and quality of potato tubers are affected.

As with pH, organic matter and nitrogen in the soil also decreased after harvest which might indicate plant absorption and utilization. In contrast, phosphorus and potassium of the soil increased after harvest which might be attributed to the continuous application of compost in the site (Anonymous, 2006).

Longlong, La Trinidad

The pH, phosphorus, and potassium of the soil increased after harvest which might be due to the continuous application of compost and green manure in the site. Continuous application of compost has been shown to increase soil phosphorus levels. In addition, compost made from grasses has been shown to contain approximately twice the potassium content of chicken manure (Anonymous, 2006).

Soil organic matter and nitrogen, however decreased which may be a result of plant absorption and utilization.

Soil organic matter may enhance the processing quality of potato accessions by producing healthy tubers.

Sinipsip, Buguias

An increase of soil pH, organic matter, nitrogen, and potassium was observed after harvest. The increase in these soil properties might be due to the compost applied during the growth and development of the plants. Experiments have shown that application of compost increases organic matter and nitrogen levels in the soil (Anonymous, 2006)

The nitrogen content of the soil might affect dry matter and reducing sugar content of the potato tubers (Beukema and Van der Zaag, 1979). In fact, potatoes harvested from Sinipsip had the lowest dry matter which may be attributed to little or no absorption of nitrogen.

Soil phosphorus, on the other hand, decreased from 360 ppm to 315 ppm after harvest. The decrease in phosphorus might be attributed to plant absorption or the occurrence of high rainfall in the site. Experiments showed that loss of phosphorus through leaching often occurs in areas with high rainfall (Black, 1968).

Loo, Buguias

Similarly, pH, organic matter, nitrogen, and potassium of the soil increased after harvest. The compost, which was applied by the farmer, could have increased these soil properties.

The decrease of phosphorus after harvest could be due to plant absorption. Phosphorus contributes to early tuberization in potatoes (Beukema and Van der Zaag, 1979). Thus, phosphorus may contribute to high yield and tuber quality of potatoes.

Balili, La Trinidad

Soil pH and potassium increased after harvesting which might be due to the compost applied to the soil. Compost made from grasses was found to have higher potassium than manure (Anonymous, 2006). Potassium does not always affect yield of potatoes but influence tuber quality especially dry matter content (Beukema and Van der Zaag, 1979).

The decrease in organic matter and nitrogen, on the other hand, could be attributed to the absorption and utilization of the plants. Phosphorus content of the soil remained the same even after harvest which may be an indication that the phosphorus absorbed may have been replaced by the growth enhancer applied to the soil.

Cabutotan, Bakun

A decrease in soil pH from 6.25 to 5.96 was observed after harvest. The decrease in soil pH might be attributed to the relatively low temperature (16.19^{0}C) and high relative humidity (87.50%) in the site. Low evaporation of water in the soil due to high relative humidity and low temperature favors acidity or decrease in soil pH (Singer and Munns, 2002).

Similarly, a decrease of organic matter and nitrogen after harvest was observed which might be due to plant absorption.

Phosphorus and potassium, on the other hand, increased after harvest which might be due to the compost applied by the farmer.

Total Yield

Effect of Production Sites

Highly significant differences were observed in the yield of potatoes planted in the different production sites (Table 4).

Table 4. Total yield of the potato accessions grown organically in different production sites

TREATMENT	TOTAL YIELD (g/plant)
Production Site (S)	
Englandad	31.36[c]
Longlong	61.57[a]
Sinipsip	25.84[c]
Loo	40.41[bc]
Balili	50.20[ab]
Cabutotan	53.45[ab]
Accession (A)	
380251.17	58.61[b]
676070	38.75[c]
Ganza	37.47[c]
285411.22	17.93[d]
573275	34.75[c]
676089	58.13[b]
5.19.2.2	40.71[c]
575003	27.39[cd]
13.1.1	80.51[a]
S x A	ns
CV (%)	49.94

Potatoes from Longlong significantly produced the highest yield per plant (61.57) but were comparable with those harvested from Balili (50.20) and Cabutotan (53.45). Potatoes grown at Sinipsip produced the lowest yield per plant (25.84).

Yields are often a reflection of soil, weather, and management of the farmer (Dahnke, 1993). Farmers in countries like Indonesia obtained low yields from potato cultivars suited for processing due to inappropriate cultural management practices employed. The farmers employed their usual management practice for Granola which was a common variety among them at that time (Sinung-Basuki, *et al.*, 2000). Researchers later found out that some potato cultivars suitable for processing require certain cultural management practices for higher yield. Thus, high yield of potato plants in Longlong may be attributed to the cultural management of the farmer. The plants were sown in pots containing soil and compost. The pots were also placed in open plastic houses where the plants were protected from rain and wind. The tubers might have developed undisturbed by factors that might affect potatoes planted in open fields. The compost applied to the soil might have also provided better nutrition for high yield as shown by the soil properties in Table 3.

Furthermore, temperature and relative humidity in Longlong is within the ideal temperature and relative humidity for potato growth and development (Table 2).

Low yield exhibited by potatoes grown at Sinipsip, on the other hand, may be attributed to the unfavorable environmental conditions of the site. Sinipsip was mostly wet (90.83% RH), cold (13.07^{0}C), and cloudy during the growth of the potato plants. The soil was also wet most of the time thus decreasing soil oxygen and causing tuber damage leading to low yield (Sano, undated). It was also observed that the conditions at Sinipsip did not only affect yield but also quality of the chips. Some of the chips had purple pigments and soap-like taste.

Effect of Potato Accessions

Accession 13.1.1 significantly produced the highest yield of 80.51 g/plant while 285411.22 produced the lowest yield (17.33 g/ plant) but was comparable with most of the accessions.

The yield differences among the accessions may be attributed to the genetic make-up of the accessions and the environmental conditions of the production site.

It is important that a variety suitable for chipping has high yield. A high yield will encourage farmers to cultivate such a variety making it easily available to processors. A high yielding variety might also satisfy the quantity needed by the processors for chipping.

In addition, tubers with high yield tend to have high dry matter content and better quality of finished chips (Tawfik *et al.*, 2002). Accession 13.1.1 having the highest yield is among the accessions with high dry matter content and chip recovery.

Interaction Effect

No significant differences are observed in the interaction of production sites and potato accessions.

Accession 13.1.1 consistently produced the highest yield in all production sites except at Longlong where 676089 had the highest yield. Furthermore, most of the accessions namely 380251.17, Ganza, 573275, and 676089 gained the highest yield at Englandad while other high yielders were harvested from Cabutotan and Balili.

Experiment 2: Processing Quality of Potato Accessions in Different Production Sites

Tuber Characteristics

Tuber Skin

Accessions 380251.17, Ganza, 573275, 676089, and 13.1.1 had yellow tuber skins in all production sites (Table 5a).

Table 5a. Tuber skin color of the potato accessions grown organically in different production sites

ACCE-SSION	ENGLAN - DAD	LONG-LONG	SINIPSIP	LOO	BALILI*	CABUTO - TAN
380251.17	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
676070	Pink and purplish red around eyes	Pink and purplish red around eyes	Pink and red around eyes	Pink and purplish red around eyes	Pink and purplish red around eyes	Pink and purplish red around eyes
Ganza	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
285411.22	Purplish-red	Purplish-red	Purplish-red	Purplish-red	Purplish-red	Purplish-red
573275	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
676089	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
5.19.2.2	Yellow	Brownish	Yellow	Brownish	Brownish	Yellow
575003	Yellow	Brownish	Brownish	Brownish	Yellow	Yellow
13.1.1	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow

* Standard character

Accessions 676070 and 285411.22 also retained their tuber skin color of pink and purplish red respectively in all sites. The skin color of pink to red potato tubers is due to the presence of anthocyanin pigments dissolved in the cell sap of the periderm cells and the outer layer cells of the cortical parenchyma (Van Es and Hartmans, 1981).

Accession 5.19.2.2, on the other hand, originally had brownish tuber skin that changed to yellow in Englandad, Sinipsip, and Cabutotan. Similarly, accession 575003 with yellow tuber skin turned brownish in Longlong, Sinipsip, and Loo.

Skin color is caused by the presence of certain pigments in the cell sap of periderm cells (Van Es and Hartmans, 1981). The change in skin color of potato tubers in some sites might be attributed to higher or lower concentrations of such pigments making the tuber skin appear darker or lighter. The conditions in the production sites might have affected pigment production in the periderm.

In addition, tuber skin color is an inherent characteristic of the accession and is one factor that may affect chip quality. Potato accessions with pink to red peel for instance, shows up as a dark ring on the slice after chipping. Thus, tuber skin must be buff (dull yellow) to tan colored (Gould, 1988) to reduce losses.

In terms of skin color, most of the accessions may be chipped even without peeling. Using accessions 676070 and 285411.22 in chipping is however a disadvantage due to their pinkish and purplish red tuber skin color.

Tuber Skin Type

Accessions 676070, Ganza, 676089, and 575003 retained their smooth tuber skins across locations (Table 5b). Accessions 380251.17 and 285411.22, on the other hand, originally had smooth tuber skins that turned rough in Longlong and Loo.

Table 5b. Tuber skin type of the potato accessions grown organically in different production sites

ACCE-SSION	ENGLAN - DAD	LONG-LONG	SINIPSIP	LOO	BALILI*	CABUTO - TAN
380251.17	Smooth	Rough	Smooth	Smooth	Smooth	Smooth
676070	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Ganza	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
285411.22	Smooth	Rough	Smooth	Rough	Smooth	Smooth
573275	Smooth	Netted	Smooth	Smooth	Smooth	Netted
676089	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
5.19.2.2	Smooth	Netted	Smooth	Smooth	Netted	Netted
575003	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
13.1.1	Smooth	Smooth	Smooth	Netted	Netted	Netted

* Standard character

Similarly, accession 573275 had smooth tuber skin that turned netted in Longlong and Cabutotan. In contrast, accessions 5.19.2.2 and 13.1.1 had netted tuber skins that turned smooth in some sites.

The varying skin types of potato tubers across locations might be attributed to the positioning of cell layers in the periderm of the tubers. Smooth skinned potatoes (e.g. 575003) have cell layers that remain in position while netted to rough skinned tubers have cell layers that have become partly detached giving rise to a rough surface (Van Es and Hartmans, 1981). The conditions in the sites (e.g. soil type, cultural and environmental conditions, stem maturity, etc.) might have influenced the positioning of such cell layers (Nolte and Olsen, 2006).

Smooth skin is preferred in tuber for chip processing. Peeling becomes more efficient and peeling loss is reduced. Accessions with netted peel generally increases peel loss and decrease chip recovery as a result (Gould, 1988).

Thus, accessions which showed consistently smooth tuber skin might be more advantageous in decreasing peel loss during processing.

<ins>Tuber Flesh Color</ins>

The tubers of the different potato accessions had varying flesh colors across locations (Table 5c). Accessions 380251.17, 573275, and 676089 had cream tuber flesh but turned to pale yellow in some production sites. Ganza with pale yellow tuber flesh in most sites turned to cream in Englandad.

Table 5c. Tuber flesh color of the potato accessions grown organically in different production sites

ACCE-SSION	ENGLAN-DAD	LONG-LONG	SINIPSIP	LOO	BALILI*	CABUTO-TAN
380251.17	Cream	Cream	Pale yellow	Pale yellow	Cream	Pale yellow
676070	Pale yellow	Pale yellow	Yellow	Yellow	Yellow	Pale yellow
Ganza	Cream	Pale yellow	Pale yellow	Pale yellow	Pale yellow	Pale yellow
285411.22	White	White	Pale yellow	Cream	Cream	Cream
573275	Cream	Pale yellow	Cream	Cream	Cream	Cream
676089	Cream	Cream	Pale yellow	Pale yellow	Cream	Cream
5.19.2.2	Yellow	Yellow	Yellow	Yellow	Pale yellow	Yellow
575003	Yellow	Pale yellow	Pale yellow	Pale yellow	Pale yellow	Yellow
13.1.1	Pale yellow	Yellow	Yellow	Yellow	Yellow	Yellow

* Standard character

Accessions 676070 and 13.1.1, on the other hand, had yellow tuber flesh that turned to pale yellow in Englandad, Longlong, and Cabutotan. In contrast, accessions 5.19.2.2 and 575003 had pale yellow tuber flesh that turned to yellow in some production sites such as Englandad and Cabutotan.

Finally, accession 285411.22 originally had cream tuber flesh which turned to white in Englandad and Longlong, and pale yellow in Sinipsip.

Tuber flesh colors (especially of yellow and white tubers) are due to the presence or absence of carotenoids (Brown *et.al.*, 1993 cited by Edwards *et.al.*, 2002). Such pigments have higher concentrations in yellower tubers and lower concentrations in whiter fleshed tubers. Furthermore, it appears that temperature may increase or decrease the production of these pigments making tuber flesh color darker or lighter. Thus, the varying flesh colors of the different accessions across sites might be attributed to the differing concentrations of their pigments (e.g. carotenoids) as affected by temperature in the production site.

Processors, however, are more concerned with the color of chips after frying rather than tuber flesh color itself. But, potato tubers with white to yellow flesh colors are commonly used.

Tuber Shape

Tuber shape of the different accessions varied across locations (Table 5d). Accessions 380251.17 and 676070 originally had round tubers that became oblong and elliptic respectively in some sites.

Table 5d. Tuber shape of the potato accessions grown organically in different production sites

ACCE-SSION	ENGLAN - DAD	LONG-LONG	SINIPSIP	LOO	BALILI*	CABUTO - TAN
380251.17	Oblong	Oblong	Oblong	Oblong	Round	Elliptic
676070	Round	Elliptic	Round	Round	Round	Oblong
Ganza	Round	Oblong	Oblong	Oblong	Ovate	Obovate
285411.22	Ovate	Round	Round	Oblong	Com-pressed	Round
573275	Oblong	Obovate	Oblong	Elliptic	Ovate	Oblong
676089	Long oblong	Elliptic	Elliptic	Ovate	Ovate	Elliptic
5.19.2.2	Ovate	Obovate	Elliptic	Ovate	Ovate	Obovate
575003	Oblong	Oblong	Oblong	Obovate	Oblong	Oblong
13.1.1	Round	Oblong	Oblong	Round	Oblong	Com-pressed

* Standard character

Ganza, 573275, 676089, and 5.19.2.2 produced ovate tubers in Balili but tuber shape changed to round, oblong, obovate, and elliptic in some production sites. Accessions 575003 and 13.1.1 also had oblong tubers that changed from round to compressed tubers in other production sites.

Finally, accession 285411.22 produced compressed tubers in Balili but tuber shape changed to round in Longlong, Sinipsip, and Cabutotan; ovate on Englandad; and oblong in Loo.

Tuber shape is relatively a varietal characteristic. However, growing conditions may cause variations from this genetically determined trait (Van Es and Hartmans, 1981). Thus, the differing conditions (e.g. soil type, cultivation, spacing, etc.) in each site might have also influenced the varying tuber shapes of each accession.

Shape of tubers is of particular importance in determining the suitability of potatoes for the chip market. Shape of tubers directly affects the number of slices per tuber and peel loss (Gould, 1988). Chippers prefer round to oblong shaped tubers since their shape facilitates the removal of the peel more efficiently and with less solid loss (Gould, 1988). Moreover, round to oblong shaped tubers tend to have higher chip recovery. Thus, accessions such as 676070, 13.1.1, 380251.17, and others which were round to oblong had high chip recoveries.

Tuber Eye Depth

Tuber eye depth varies across sites and within accessions (Table 5e). Most of the potato accessions (e.g. 13.1.1, 5.19.2.2, 676089, etc) had shallow tuber eye depths that changed from medium to very deep in some production sites.

Accessions 285411.22, on the other hand, had medium tuber eye depths that became shallow in Longlong but very deep in Englandad and Cabutotan. Also, the eyes of accession 575003 originally protruded in Balili but sank to shallow or medium in most locations except Longlong.

Table 5e. Tuber eye depth of the potato accessions grown organically in different production sites

ACCE-SSION	ENGLAN-DAD	LONG-LONG	SINIPSIP	LOO	BALILI*	CABUTO-TAN
380251.17	Very deep	Shallow	Shallow	Shallow	Shallow	Shallow
676070	Medium	Shallow	Medium	Medium	Shallow	Medium
Ganza	Medium	Shallow	Shallow	Shallow	Shallow	Shallow
285411.22	Very deep	Shallow	Medium	Medium	Medium	Very deep
573275	Medium	Shallow	Shallow	Shallow	Shallow	Medium
676089	Shallow	Shallow	Shallow	Shallow	Shallow	Shallow
5.19.2.2	Medium	Shallow	Shallow	Shallow	Shallow	Shallow
575003	Medium	Protruding	Shallow	Shallow	Protruding	Shallow
13.1.1	Shallow	Shallow	Medium	Shallow	Shallow	Shallow

* Standard character

The varying eye depths of potato tubers across sites might be attributed to the formation of cell layers in the tuber periderm (Van Es and Hartmans, 1981). It is probable that conditions in the site (e.g. soil type, temperature, relative humidity, etc.) might have affected cell layer formation giving rise to shallow or deep tuber eyes

In addition, eye depth is an inherited characteristic and is often considered as part of the shape (Gould, 1988). To reduce peel loss, cultivars with shallow eye depths are preferred for processing. If eyes are too deep, it is necessary to peel longer and deeper to remove the eye. Further, the eyes should not be colored since they turn black or brown on chipping and end up as a defect (Gould, 1988).

Thus, the use of accessions 676089 and 13.1.1 may result in reduced peel loss during chipping since both had consistently shallow eye depth in most sites. Further, their yellow eye color is consistent with the tuber skin color and thus may not cause browning on chip.

Dry Matter Content

Effect of Production Sites

Highly significant differences were observed in the dry matter content of tuber of the potato accessions planted in the different sites (Table 6). Potatoes grown at Balili significantly had the highest dry matter content of tubers while those grown at Sinipsip had the lowest. The rest of the accessions grown at Englandad and Longlong, Loo and Cabutotan had comparable tuber dry matter contents.

Dry matter content in the tubers is correlated with the potato variety, but apart from this, soil type, climate, fertilization, pest control, etc. are also of importance (Hesen and VanderSchild, 1979). Potatoes harvested from Sinipsip, for instance, had the lowest dry matter content which may be an effect of the high relative humidity (92.88%) of the site. Excessive water from high rainfall or relative humidity will often result in tubers with low dry matter (Kellock, 1995).

Table 6. Dry matter content of tubers of the potato accessions grown organically in different production sites

TREATMENT	DRY MATTER CONTENT (%)
Production Site (S)	
Englandad	20.11[b]
Longlong	19.83[b]
Sinipsip	17.42[d]
Loo	18.70[c]
Balili	20.78[a]
Cabutotan	19.01[c]
Accession (A)	
380251.17	18.61[c]
676070	18.00[c]
Ganza	18.44[c]
285411.22	18.42[c]
573275	20.14[ab]
676089	20.62[a]
5.19.2.2	20.47[a]
575003	19.08[bc]
13.1.1	20.03[ab]
S x A	**
CV (%)	9.82

Furthermore, continuous cloud cover will decrease dry matter by reducing the photosynthetic rate of the plant. It was observed that Sinipsip was continually wet and cloudy which might have greatly contributed to the low dry matter content of the potato accessions.

The high dry matter content of potatoes grown in Balili, on the other hand, might be due to the optimum environmental condition of the site. Potatoes normally grow best in areas with a temperature of 15 to 22^0C (Sano, undated) and Balili is within the optimum temperature range for growing potatoes.

Effect of Potato Accessions

Highly significant differences are likewise observed in the tuber dry matter content of the nine accessions used. Accession 676089 and 5.19.2.2 significantly had the highest tuber dry matter content but were comparable to the tubers of 573275 and 13.1.1. The tubers of the remaining accessions are not significantly different from each other.

Dry matter content is a strongly inherited characteristic (Kellock, 1995). Varieties with higher dry matter content (>18%) tend to have higher yields and better quality of finished chips (Tawfik *et.al.*, 2001). A high dry matter also results in lower oil absorption of the chip during frying (Hesen and Van der Schild, 1979). In terms of dry matter alone, all the accessions may be processed into potato chips since they have tuber dry matter contents of above 18%.

However, for better chip quality, a tuber dry matter content of 20.3 – 22.3% is best (Mosley and Chase, 1993). Accessions 676089 and 5.19.2.2 may yield better chips compared with the other accessions.

Interaction Effect

A highly significant interaction is observed between production site and the different potato accessions on dry matter content. Furthermore, 68% (R-value) of the differences in dry matter content are due to the interaction of the two factors, which mean that both factors are important in the selection for chip processing.

Accessions 5.19.2.2 and 13.1.1 had consistently dry matter content of 18% and above across all locations (Fig. 1). Although these accessions were exposed to different organic management practice and environmental conditions, these accessions still retained high dry matter content for chipping. Dry matter though affected by different factors is still largely attributed to the genetic make-up of the accessions.

Furthermore, dry matter content of above 18% was exhibited by all the accessions harvested from Balili. The other sites revealed accessions with lower than 18% dry matter content. However, the most accessions (380251.17, Ganza, 573275, 5.19.2.2, 13.1.1) with the highest tuber dry matter content were harvested from Englandad.

Conditions in the production site also have a bearing on increasing or decreasing dry matter content of potato accessions. Selection of sites for production of potatoes intended for chipping is, thus, important.

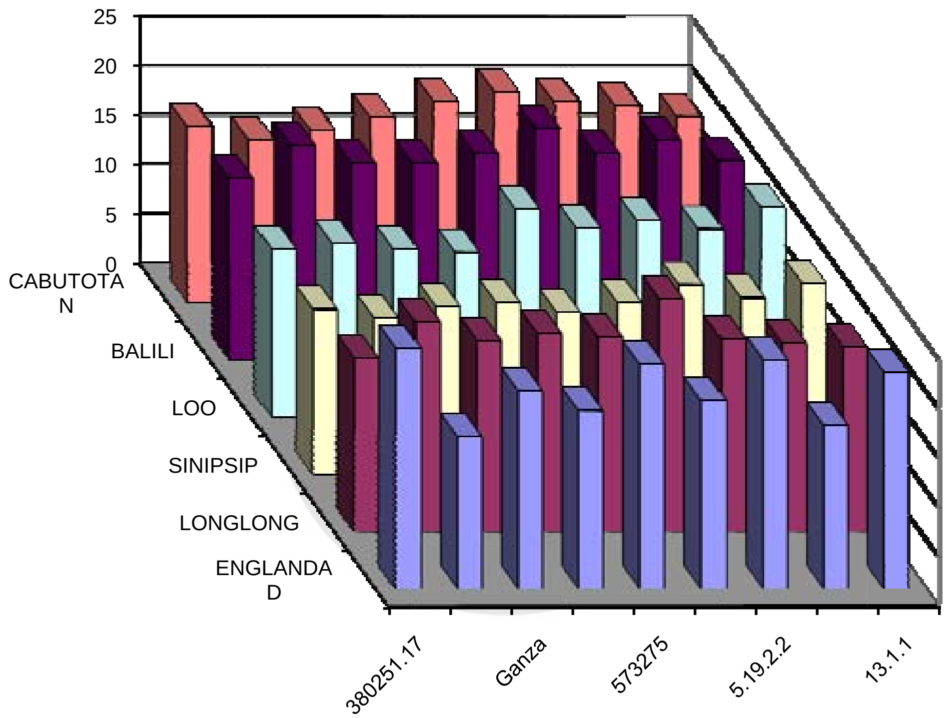

Figure 1. Dry matter content (%) of the potato accessions grown organically in different production sites

Specific Gravity

Effect of Production Sites

Highly significant differences can be observed in the specific gravity of the potatoes harvested from the different sites (Table 7).

Table 7. Specific gravity of the potato accessions grown organically in different production sites

TREATMENT	SPECIFIC GRAVITY
Production Site (S)	
Englandad	1.084[a]
Longlong	1.073[abc]
Sinipsip	1.060[c]
Loo	1.067[bc]
Balili	1.077[ab]
Cabutotan	1.069[bc]
Accession (A)	
380251.17	1.071[ab]
676070	1.063[b]
Ganza	1.068[ab]
285411.22	1.066[ab]
573275	1.075[ab]
676089	1.076[ab]
5.19.2.2	1.084[a]
575003	1.069[ab]
13.1.1	1.074[ab]
S x A	**
CV (%)	2.26

Potatoes harvested from Englandad had the highest specific gravity but comparable with potatoes harvested from Longlong and Balili. Lowest specific gravity is found in potatoes harvested from Sinipsip.

Specific gravity is a measure of the potato solids or water content. It influences the processing efficiency, oil absorption of the finished chip, and the chip recovery (Gould, 1988). Specific gravity may be influenced by environmental factors in the production site (Stark *et.al.*, 2003).

Temperature is the primary factor affecting specific gravity. High temperature in a site often inhibits starch deposition and decrease specific gravity. Thus, relatively low temperatures are ideal for increasing specific gravity. Englandad, Longlong, and Balili had relatively low temperatures ideal for starch deposition and increased specific gravity.

Sinipsip produced potatoes with low specific gravity which might be attributed to the high relative humidity and prolonged overcast skies of the site. High relative humidity may reduce photosynthetic rate to levels below that required for maximum starch deposition, thus, lowering specific gravity (Stark *et al.*, 2003).

Effect of Potato Accessions

Accession 5.19.2.2 significantly had the highest specific gravity but comparable with the rest of the accessions except 676070 which had the lowest specific gravity.

Generally, high chip recovery is obtained from accessions with high specific gravity. Such accessions also have been shown to absorb less cooking oil during the chipping process (Gould, 1988). Thus, accessions 5.19.2.2 including 13.1.1 which had one of the highest specific gravity also had one of the highest chip recovery and moderately oily chips. It also had one of the highest dry matter content, thus confirming Gould's (1988) statement that specific gravity and dry matter are positively correlated.

Interaction Effect

The highly significant interaction between accessions and production sites implies that both factors influence specific gravity of potato tubers.

Most accessions with high specific gravity were harvested from Englandad while those with low specific gravity were taken from Sinipsip (Fig. 2). This shows that environmental conditions in Englandad may have enhanced or increased the specific gravity of the potato accessions. Relatively low temperature and relative humidity in the production site may enhance the performance of potato accessions with increased specific gravity, thus, improve chipping quality.

Accessions 5.19.2.2 and 13.1.1, on the other hand, had the highest specific gravity. These accessions might yield higher chips and absorb less oil. Selection, therefore, of a suitable accession and appropriate production site is important in improving chipping quality.

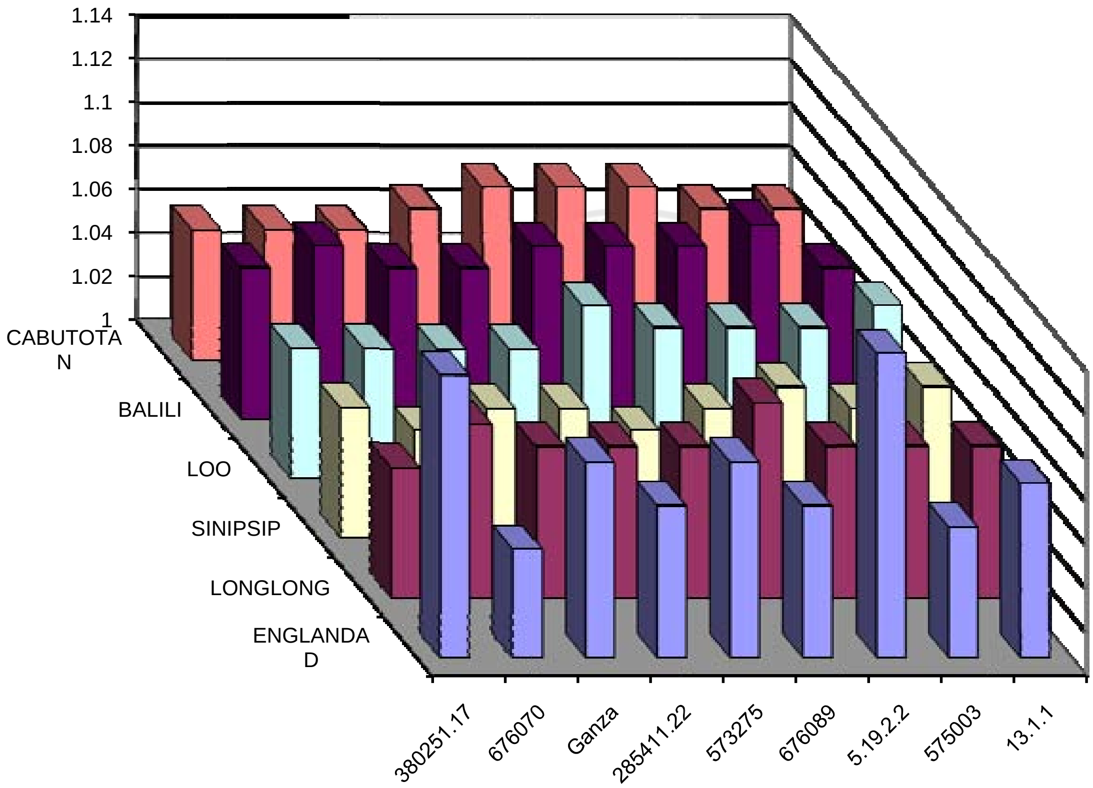

Figure 2. Specific gravity of the potato accessions grown organically in different production sites

Sugar Content

Effect of Production Sites

Sugar content in potatoes is one of the determining factors with respect to the suitability of a potato variety for the processing industry (Coumou, 1991).

Table 8. Sugar content of the potato accessions grown organically in different production sites

TREATMENT	SUGAR CONTENT (^{0}Brix)
Production Site (S)	
Englandad	4.16[ab]
Longlong	4.31[a]
Sinipsip	3.55[c]
Loo	4.38[a]
Balili	3.94[abc]
Cabutotan	3.72[bc]
Accession (A)	
380251.17	3.72
676070	4.29
Ganza	4.07
285411.22	3.84
573275	4.01
676089	3.96
5.19.2.2	3.91
575003	4.41
13.1.1	3.88
S x A	**
CV (%)	16.98

The sugar content of tubers largely depends on the genetic make-up of the variety but may also be affected by the soil type, manuring, weather conditions, etc. (Hesen, 1985) in the production site. Low sugar content results in better quality of the processed product.

Potatoes produced from Sinipsip had significantly the lowest sugar content but were comparable with potatoes harvested from Balili and Cabutotan (Table 8). The highest sugar content was obtained from potatoes harvested in Loo and Longlong.

One of the important factors affecting sugar production in tubers is air and soil temperature. The low sugar content in potatoes from Sinipsip might be attributed to the low temperature of the place. Low sugar production in tubers happens at a temperature range of 8-12^{0}C (Hesen, 1985). Sinipsip had a temperature range of 9.50 - 14.12^{0}C which might have contributed to low sugar production in the tubers.

As a general rule, however, any environmental factor that increases specific gravity also decreases sugars and vice versa (Stark *et al*., 2003).

Effect of Potato Accessions

No significant differences were observed in the sugar content of the tuber of the different potato accessions. Tuber of accession 380251.17 had the lowest sugar content while accession 575003 had the highest.

Sugar content varies considerably between varieties and is an inherited characteristic as reported earlier. Thus, the different sugar contents of the tubers of the accessions may be attributed to the genetic make-up.

Sugar content of tubers also plays an important role in the color of the resulting chips. High sugar content results in discolored or brown chips, which are unacceptable to consumers (Verma, 1991). Accessions with low sugar content of 0.5 to 2.0% usually results in light colored chips and accessions with sugar contents higher than 2% are unacceptable for frying (Feltran *et al.*, 2004). However, there were cases when accessions with as high as 6.69^0 Brix were used for frying with no problems on chip quality (Feltran *et.al.*, 2004). Thus, all the accessions may produce light colored chips with no browning.

Interaction Effect

A highly significant interaction is observed in the sugar content of the different accessions harvested from the different production sites. Most of the tubers from accessions with low sugar content were harvested from Sinipsip (Fig. 3). This result may be attributed to the weather condition of the site. Low light intensity due to cloudy skies and high relative humidity might have decreased photosynthetic rate and thus sugar production in the tubers. Lowest sugar content of tubers was exhibited by accession 13.1.1 harvested from Cabutotan. This result was confirmed by the light yellow chips with no browning produced from the accession.

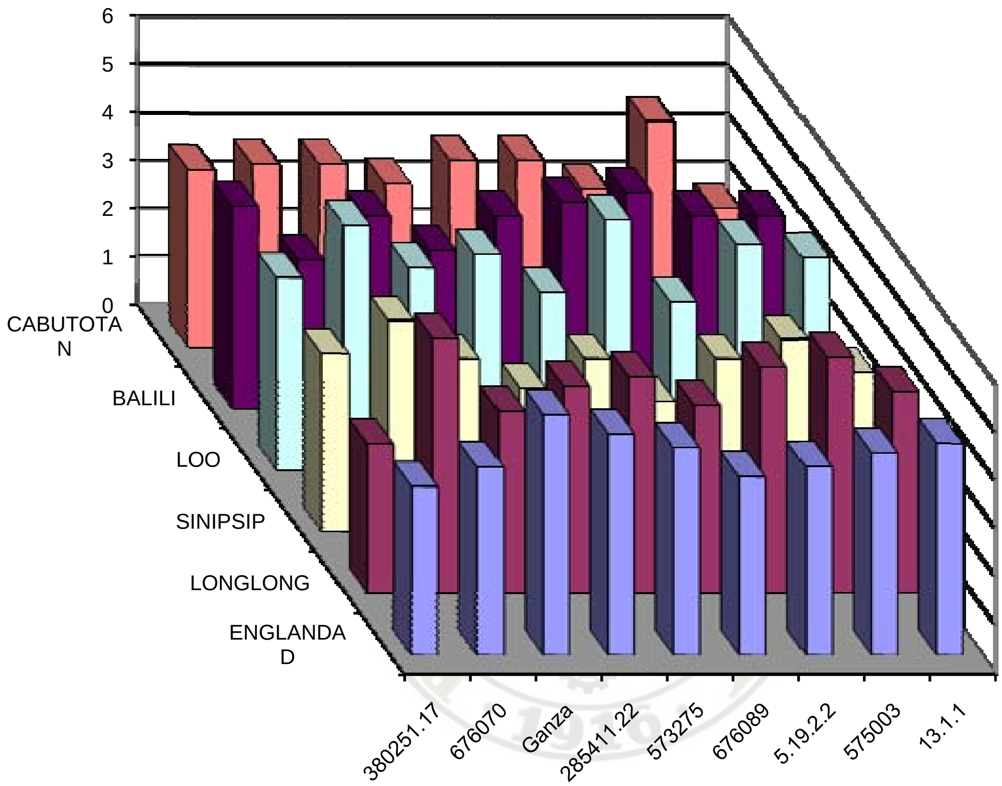

Figure 3. Sugar content of the potato accessions grown organically in different production sites

Chip Recovery

Effect of Production Sites

Highly significant differences were observed in the chip recovery of the potatoes harvested from the different sites (Table 9).

Table 9. Chip recovery of the potato accessions grown organically in different production sites

TREATMENT	CHIP RECOVERY (%)
Production Site (S)	
Englandad	80.58[ab]
Longlong	77.63[ab]
Sinipsip	69.85[c]
Loo	76.62[b]
Balili	82.74[a]
Cabutotan	80.83[ab]
Accession (A)	
380251.17	81.41[a]
676070	81.78[a]
Ganza	78.04[ab]
285411.22	69.94[c]
573275	80.11[a]
676089	80.03[a]
5.19.2.2	78.57[ab]
575003	74.88[b]
13.1.1	78.07[ab]
S x A	*
CV (%)	8.62

Potatoes from Balili produced the highest percentage of chips recovered but comparable with potatoes from Cabutotan, Englandad, and Longlong.

Potatoes from Sinipsip, on the other hand, produced the least percentage of chips recovered. Chip recovery is usually attributed to dry matter or specific gravity (Verma, 1991). Dry matter, on the other hand, is affected by cultural and environmental conditions of the production site.

High dry matter of tubers usually produces high chip recovery. Thus, potatoes from Balili which had the highest dry matter also had the highest chip recovery. Likewise, potatoes harvested from Sinipsip had the lowest chip recovery which might be attributed to the low dry matter.

Effect of Potato Accessions

Chip recovery among the different accessions had highly significant differences. Accession 676070 had the highest chip recovery but not significantly different from the rest of the accessions except for accessions 285411.22 and 575003.

Chip recovery is directly related to the dry matter (Verma, 1991) and shape of the tuber (Gould, 1988). A high dry matter often results to increased chip recovery. Round shaped tubers with a smooth surface is also preferred for easier chipping and higher chip production (Gould, 1988).

Accessions with high chip recovery such as 573275, 676089, 13.1.1, etc also had relatively high dry matter contents. It is therefore important to choose accessions with high dry matter for higher chip yield. There are exceptions however, in accessions that have high dry matter but are prone to damage. Such accessions become unacceptable for chipping. Damage decreases chip yield.

Interaction Effect

A significant interaction is observed which means that production site and potato accessions play an important role in increasing chip recovery. Suitable chipping varieties grown in appropriate production sites must be selected for high chip recovery.

High chip recovery was observed from potatoes harvested at Longlong and Balili. Conditions in these sites might have enhanced chip recovery of the accessions (Fig. 4).

Accession 380251.17 had the highest chip recovery which might be attributed to its relatively high dry matter content.

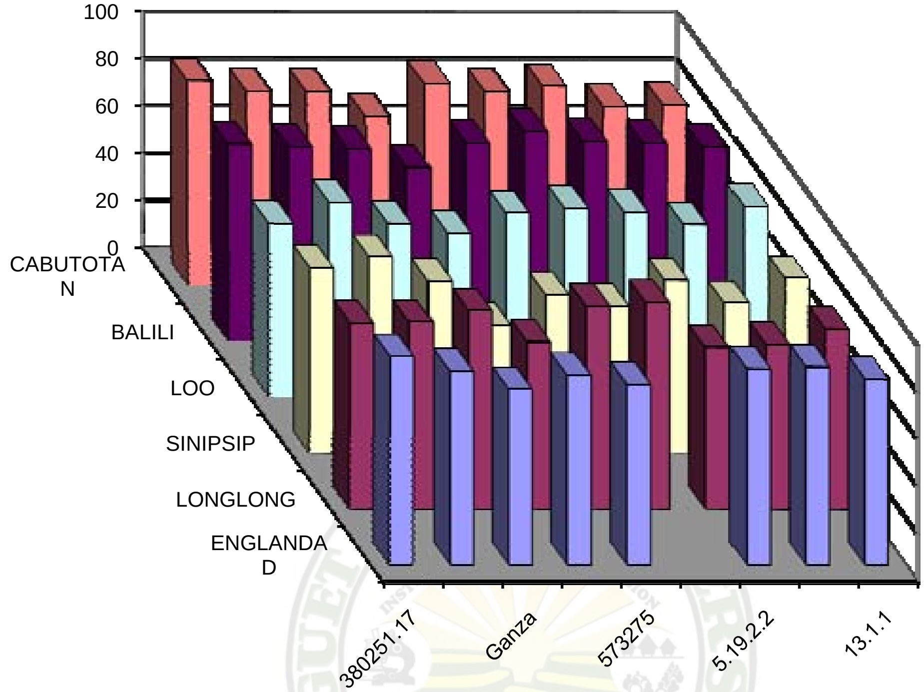

Figure 4. Chip recovery of the potato accessions grown organically in different production sites

Chip Color

Effect of Production Sites

Color is one of the most important factors in the evaluation of tubers for chipping (Gould, 1988). Potatoes harvested from Longlong, Balili, and Cabutotan produced light yellow chips while the rest of the accessions produced yellow brownish chips (Table 10).

Table 10. Chip color of potato accessions grown organically in different production sites

TREATMENT	CHIP COLOR
Production Site (S)	
Englandad	3.00^{b}
Longlong	3.00^{b}
Sinipsip	4.00^{a}
Loo	4.00^{a}
Balili	3.00^{b}
Cabutotan	3.00^{b}
Accession (A)	
380251.17	3.00^{b}
676070	4.00^{a}
Ganza	4.00^{a}
285411.22	3.00^{b}
573275	4.00^{a}
676089	3.00^{b}
5.19.2.2	3.00^{b}
575003	4.00^{a}
13.1.1	3.00^{b}
S x A	*
CV (%)	13.99

The ideal color of chips is usually light yellow to yellow. Chip color may be influenced by the growing environment, fertilization, cultural practices, or any factor that will affect sugar content (Gould, 1988). Thus, the light yellow color of chips produced by the potatoes harvested from Longlong, Balili, and Cabutotan may be attributed to the weather and farmer's practices in the sites. It may also be attributed to the relatively low sugar content of the potatoes harvested from the sites.

Effect of Potato Accessions

Highly significant differences were observed in the sugar content of the different accessions. Accessions 380251.17, 285411.22, 676089, 5.19.2.2 and 13.1.1 produced light yellow chips while the rest of the accessions produced yellow brownish chips.

Chip color is determined to a large extent by the sugar content of the potato accession. The higher the sugar content the darker is the chip color. A dark chip color might result to browning and bitter taste, which is unacceptable to consumers (Kaiyun *et al.*, 2004).

Accessions which produced light colored chips had relatively low sugar contents (3.72 to 3.96^0 Brix). The yellow brownish chips were produced from accessions with high sugar content (4.07 to 4.4^0 Brix). Dark colored chips are generally the result of too high sugar content (Gould, 1988).

Interaction Effect

A significant interaction between accession and production site on chip color is observed. This result indicates that the appropriate accession must be grown in the right production site to produce light colored chips.

All the accessions harvested from Cabutotan produced light yellow chips while most accessions from Englandad produced yellow brownish chips (Fig. 5). Furthermore, accession 13.1.1 consistently produced light yellow chips in all locations except at Balili. In contrast, accession 676070 produced yellow brownish chips to brown chips.

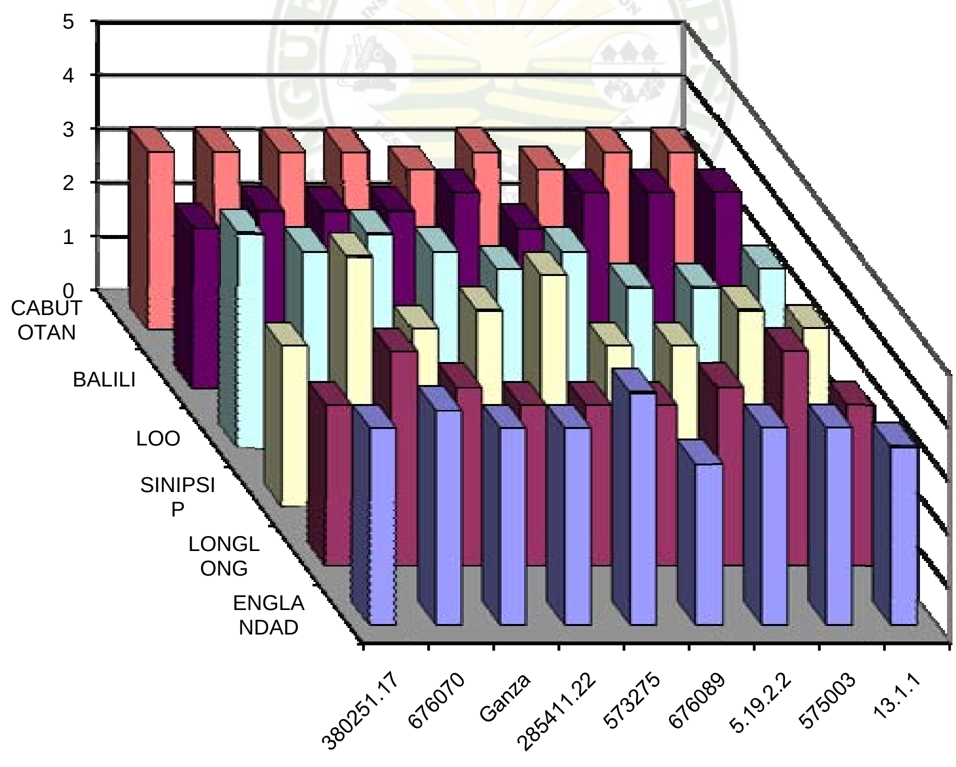

Figure 5. Chip color of p

Chip Browning

Effect of Production Sites

There was no browning from the chips produced by the accessions harvested from Longlong and Cabutotan while slight browning was observed from the accessions harvested from the remaining production sites (Table 11).

Table 11. Chip browning of the potato accessions grown organically in different production sites

TREATMENT	BROWNING PATTERN
Production Site (S)	
Englandad	Slight
Longlong	None
Sinipsip	Slight
Loo	Slight
Balili	Slight
Cabutotan	None
Accession (A)	
380251.17	None
676070	Slight
Ganza	Slight
285411.22	Slight
573275	Slight
676089	Slight
5.19.2.2	None
575003	None
13.1.1	None

Browning is a consequence of high sugar content. The sugars will react with the amino acids (Maillard reaction) present in the tuber and cause chips to fry dark or brown (Gould, 1988). Sugar content, on the other hand, is a consequence of the condition of the production site.

There were cases, however, of tubers with as high as 6.69^0 Brix sugar content which were suitable to frying (Feltran *et.al.*, 2004). Although potatoes from Longlong had one of the highest sugar content, browning was not observed.

Effect of Potato Accessions

No browning was observed in the chips processed from accessions 380251.17, 5.19.2.2, 575003, and 13.1.1. The tubers from the rest of the accessions showed chips with slight browning.

Browning is attributed to the amount of sugar in the tuber. A low sugar content usually limits excessive browning in the final chip (Gould, 1988). This claim is confirmed by the absence of browning in the chips processed from accessions 380251.17 and 13.1.1 which had sugar contents of 3.72 and 3.88^0 Brix, respectively.

No browning was observed in accessions 5.19.2.2 and 575003 despite their relatively high sugar content. The absence of browning in these accessions may be attributed to shorter frying time. It was observed that there were accessions which easily fry while other accessions took longer time to fry before fully cooked.

Sensory Evaluation

Effect of Production Sites

Crispiness. Moderately crispy chips were obtained from potatoes harvested from Englandad, Longlong, Sinipsip, and Loo while crispy chips were produced from Balili and Cabutotan (Table 12).

Table 12. Sensory evaluation of the potato chips processed from different potato accessions and production sites

	CRISPINESS	FLAVOR	TEXTURE	OILINESS	APPEARANCE	GENERAL ACCEPTABILITY
Production site (S)						
Englandad	Moderately crispy	Moderately perceptible	Moderately firm	Moderately oily	Like moderately	Like moderately
Longlong	Moderately crispy	Moderately perceptible	Slightly firm	Moderately oily	Like moderately	Like moderately
Sinipsip	Moderately crispy	Slightly perceptible	Slightly firm	Moderately oily	Like moderately	Like slightly
Loo	Moderately crispy	Moderately perceptible	Moderately firm	Moderately oily	Like moderately	Like moderately
Balili	Crispy	Perceptible	Moderately firm	Moderately oily	Like much	Like much
Cabutotan	Crispy	Moderately perceptible	Moderately firm	Moderately oily	Like moderately	Like moderately
Accession (A)						
380251.17	Moderately crispy	Moderately perceptible	Moderately firm	Moderately oily	Like moderately	Like moderately
676070	Moderately crispy	Moderately perceptible	Moderately firm	Moderately oily	Like moderately	Like moderately
Ganza	Moderately crispy	Moderately perceptible	Slightly firm	Moderately oily	Like moderately	Like moderately

Table 12. continued…

	CRISPINESS	FLAVOR	TEXTURE	OILINESS	APPEARANCE	GENERAL ACCEPTABILITY
285411.22	Moderately crispy	Moderately perceptible	Moderately firm	Moderately oily	Like moderately	Like moderately
573275	Moderately crispy	Moderately perceptible	Moderately firm	Moderately oily	Like moderately	Like moderately
676089	Moderately crispy	Moderately perceptible	Moderately firm	Moderately oily	Like moderately	Like moderately
5.19.2.2	Crispy	Moderately perceptible	Moderately firm	Moderately oily	Like moderately	Like moderately
575003	Crispy	Moderately perceptible	Moderately firm	Moderately oily	Like moderately	Like moderately
13.1.1	Moderately crispy	Moderately perceptible	Moderately firm	Moderately oily	Like moderately	Like moderately

Crispiness increases with dry matter content, which is in turn easily affected by conditions of the site. That the potatoes from Balili produced crispy chips, might be attributed to a high dry matter as affected by the conditions of the site.

Flavor. Moderately perceptible potato chips were produced from almost all sites except Sinipsip and Balili. Chips from Sinipsip had slightly perceptible flavor. The chips had violet pigments with soapy taste which might be attributed to the cold and high relative humidity of the site.

Chips from Balili had perceptible flavor which might be due to the good quality tubers harvested from the site.

Texture. Potato chips processed from the different sites were moderately firm except those harvested from Longlong and Sinipsip, which were slightly firm. The slightly firm texture of the chips might be due to the low dry matter of the potato accessions harvested.

Oiliness. All potato chips processed from the different sites were moderately oily. Oiliness of chips is usually affected by dry matter content of tubers which is in turn affected by environmental factors.

Appearance. Potato chips produced from potatoes harvested from all locations were liked moderately except for chips from Balili which were liked much.

General acceptability. Potato chips from Englandad, Longlong, Loo, and Cabutotan were liked moderately. Chips from Sinipsip were liked slightly while chips from Balili were liked much.

Effect of Potato Accessions

Crispiness. Most of the accessions produced tubers which were moderately crispy except the tubers of accessions 5.19.2.2 and 575003 which were crispy. Crispiness is related to the specific gravity or dry matter of the potato accession. Accessions with high specific gravity tend to produce crispy chips while those with low specific gravity produce soggy chips (Mosley and Chase, 1993). Tubers of accessions 5.19.2.2 and 575003 had one of the highest specific gravity among the other accessions.

Flavor. Tubers of all the accessions had moderately perceptible flavor. Flavor of a chip may be influenced by the potato accession itself. Sugar content and other organic compounds in the tuber often affect chip flavor (Gould, 1988).

Texture. Most of the accessions produced tubers with moderately firm chips except Ganza tubers which produced slightly firm chips. Texture of chips is influenced by dry matter content of the different tubers. Accessions with high dry matter often produce firm chips. Ganza which had one of the lowest dry matters also produced slightly firm chips.

Oiliness. All the accessions produced tubers with moderately oily chips. Oiliness of chips is often related to specific gravity of the tuber. Accessions having higher specific gravity have also been shown to absorb less cooking oil during frying (Gould, 1988). However, the influence of specific gravity of the different accessions was not clearly seen in terms of chip oiliness. This result may be attributed to the method of frying done in the study.

Appearance and general acceptability. The chips produced from tubers of all the accessions were liked moderately.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The chip quality of nine potato accessions grown organically in different production sites was evaluated. The organically grown potato accession with the best chipping quality and the effect of different production sites to chipping quality were identified.

The cultural management practices of the organic farmers, relative humidity and temperature, and soil properties in each site were also identified. It was observed that each of these factors had a contributory effect to the quality of the processed chips. For instance, dry matter and sugar content of potato tubers, which are critical quality factors for processing potatoes, are directly affected by relative humidity and temperature of the site.

Potatoes from Longlong produced the highest yield. Highest dry matter content and specific gravity were also observed from potatoes harvested from Balili and Englandad, respectively. Lowest sugar content, on the other hand, was exhibited by potatoes harvested from Sinipsip which might be due to the low temperature of the site.

Potatoes harvested from Balili produced the highest chip recovery but comparable with those harvested from Englandad, Longlong, and Cabutotan. Light yellow chips with slight to no browning were produced from potatoes

harvested in Longlong, Balili, and Cabutotan. Chips which were processed from potatoes harvested at Balili were liked much by panelists while those processed from potatoes in Sinipsip were liked slightly.

Accession 13.1.1 had the highest yield while 285411.22 produced the lowest yield per plant. Accession 676089, on the other hand, had the highest dry matter content but comparable with those of accessions 573275, 5.19.2.2, and 13.1.1. Accession 5.19.2.2 had the highest specific gravity while the lowest sugar content was measured from accession 380251.17.

Accession 676070 also had the highest chip recovery but was comparable with most of the accessions. Light yellow chips with slight to no browning were produced by most of the accessions. In addition, the chips were moderately crispy to crispy, moderately oily, and were liked moderately by panelists.

Production site and potato accession interacted significantly to affect dry matter content, specific gravity, and sugar content. A significant interaction is also observed on the chip recovery and chip color of potato tubers . This interaction means that both site and accession are important considerations in organic growing of potatoes for chipping.

<u>Conclusion</u>

Balili is a good site for organic potato production intended for processing since it consistently produced potatoes with good chip quality. Potatoes harvested from Balili had one of the highest yield, dry matter content, specific gravity, and chip recovery. Furthermore, potatoes from Balili had one of the lowest sugar content, thus, producing light yellow chips with no browning. The chips were also liked much by the panelists. Thus, conditions in Balili might have positively influenced or enhanced the characteristics of the potato accessions for chipping.

Longlong and Cabutotan might also be excellent sites for organic potato production intended for processing since potatoes harvested from the sites showed good chipping quality. The potatoes also had high yield and high chip recovery. Moreover, the chips produced were light yellow but were liked moderately by panelists.

Among the potato accessions, accession 13.1.1 consistently showed traits indicating good chip quality. It significantly produced the highest yield in most production sites which might indicate adaptability to organic production and to the local conditions of the sites. Furthermore, accession 13.1.1 had one of the highest dry matter content, specific gravity, and chip recovery. It also had one of the lowest sugar content, thus, producing light yellow chips with no browning.

Accession 5.19.2.2 also exhibited good chip quality since it had high dry matter content, specific gravity, and chip recovery. It also produced light yellow and crispy chips. However, 5.19.2.2 produced one of the lowest yields per plant, which might discourage organic farmers from growing it.

Accession 13.1.1 planted in Balili might therefore be the best treatment combination in producing tubers with good chip quality.

Recommendation

Based on the results of the study, accessions 13.1.1 and 5.19.2.2 are recommended for chip processing. Balili, Longlong, and Cabutotan may also be recommended for organic production of potato accessions suitable for chip processing.

Further evaluation of potato accessions for chipping using more efficient equipments such as fryers and chippers is also recommended for more accurate results.

Finally, development of standard organic practices for potato production is also recommended. Doing this will make evaluation of the adaptability and chipping quality of potato accessions more accurate.

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APPENDICES

Appendix Table 1. Temperature and relative humidity of the different production sites

PRODUCTION SITE	TEMPERATURE (^{0}C)	RELATIVE HUMIDITY (%)
Englandad		
October	---	---
November	17.50	86.00
December	15.06	89.00
January	16.88	88.00
MEAN	16.48	87.67
Longlong		
October	21.25	82.50
November	21.21	79.75
December	20.12	78.62
January	19.36	82.37
MEAN	20.49	80.81
Sinipsip		
November	13.65	92.50
December	13.78	96.00
January	14.12	83.00
February	9.50	100.00
MEAN	12.76	92.88
Loo		
November	17.75	86.00
December	17.06	77.00
January	19.88	51.00
February	16.25	87.00
MEAN	17.74	75.25

Appendix Table 1. continued…

PRODUCTION SITE	TEMPERATURE (^0C)	RELATIVE HUMIDITY (%)
Balili		
November	19.05	78.00
December	18.58	79.50
January	17.50	83.75
February	18.30	78.00
MEAN	18.36	79.81
Cabutotan		
December	15.00	93.50
January	16.75	78.00
February	15.50	86.50
March	17.50	92.00
MEAN	16.19	87.50

Appendix Table 2. Total Yield

PRODUCTION SITE	POTATO ACCESSION	REPLICATION I	II	III	TOTAL	MEAN
ENLANDAD	380251.17	36.76	51.32	48.57	136.65	45.55
	676070	17.74	34.38	28.26	80.38	26.79
	Ganza	15.71	10.29	10.00	36.00	12.00
	285411.22	10.71	12.50	10.71	33.93	11.31
	573275	27.78	15.71	39.71	83.20	27.73
	676089	41.67	48.68	86.20	176.56	58.85
	5.19.2.2	10.29	11.29	16.67	38.25	12.75
	575003	15.71	21.67	15.28	52.66	17.55
	13.1.1	100.00	22.72	86.36	209.09	69.70
LONGLONG	380251.17	46.67	25.00	170.00	241.67	80.56
	676070	65.71	23.75	42.50	131.96	43.99
	Ganza	87.78	82.50	106.67	276.94	92.31
	285411.22	28.75	10.00	42.86	81.61	27.20
	573275	46.67	47.50	46.25	140.42	46.81
	676089	136.00	162.50	46.00	344.50	114.83
	5.19.2.2	41.43	66.25	45.00	152.68	50.89
	575003	22.00	34.29	41.43	97.71	32.57
	13.1.1	60.00	35.00	100.00	195.00	65.00
SINIPSIP	380251.17	52.86	28.26	43.18	124.30	41.43
	676070	17.89	13.70	17.33	48.92	16.31
	Ganza	17.08	9.54	11.25	37.88	12.63
	285411.22	9.38	5.45	8.00	22.83	7.61
	573275	39.17	10.00	14.17	63.33	21.11
	676089	39.40	19.60	11.33	70.33	23.44
	5.19.2.2	42.22	17.50	27.04	86.76	28.92
	575003	13.25	13.33	16.36	42.95	14.32
	13.1.1	67.39	70.45	62.62	200.47	66.82
LOO	380251.17	14.38	42.67	70.71	127.76	42.59
	676070	40.62	40.00	20.67	101.29	33.76
	Ganza	41.55	10.38	20.50	72.43	24.14

Appendix Table 2. continued …

PRODUCTION SITE	POTATO ACCESSION	REPLICATION I	II	III	TOTAL	MEAN
LOO	285411.22	10.83	7.00	28.50	46.33	15.44
	573275	41.38	37.50	47.50	126.38	42.13
	676089	52.19	64.74	36.07	152.99	50.99
	5.19.2.2	29.00	45.00	45.62	119.62	39.88
	575003	48.67	20.38	13.67	82.72	27.57
	13.1.1	61.25	85.77	114.58	261.60	87.20
BALILI	380251.17	44.72	79.41	84.38	208.51	69.50
	676070	63.00	56.76	82.63	202.40	67.46
	Ganza	40.00	40.83	40.56	121.39	40.46
	285411.22	6.33	10.29	10.45	27.08	9.03
	573275	19.27	52.37	57.35	128.99	42.99
	676089	21.57	58.75	76.11	156.43	52.14
	5.19.2.2	0.00	75.00	53.59	128.59	42.86
	575003	58.83	21.80	58.70	139.33	46.44
	13.1.1	56.00	68.21	119.38	243.60	81.20
CABUTOTAN	380251.17	91.88	57.39	66.90	216.17	72.05
	676070	37.10	45.83	49.63	132.56	44.19
	Ganza	32.27	51.88	46.52	130.67	43.56
	285411.22	60.00	12.50	38.57	111.07	37.02
	573275	32.50	17.86	32.86	83.21	27.74
	676089	29.83	40.67	75.00	145.49	48.50
	5.19.2.2	108.40	45.17	53.33	206.91	68.97
	575003	24.54	28.75	24.44	77.74	25.91
	13.1.1	157.83	96.67	84.85	339.34	113.11

TWO – WAY TABLE

ACCESSION	ENGLANDAD	LONG-LONG	SINIPSIP	LOO	BALILI	CABUTOTAN	TOTAL	MEAN
380251.17	45.55	80.56	41.43	42.59	69.50	72.05	351.68	58.61
676070	26.79	43.99	16.31	33.76	67.47	44.19	232.51	38.75
Ganza	12.00	92.31	12.63	24.14	40.46	43.56	225.10	37.47
285411.22	11.31	27.20	7.61	15.44	9.03	37.02	107.61	17.93
573275	27.73	46.81	21.11	42.13	43.00	27.74	208.52	34.75
676089	58.85	114.83	23.44	51.00	52.14	48.50	348.76	58.13
5.19.2.2	12.75	50.89	28.92	39.88	42.86	68.97	244.27	40.71
575003	17.55	32.57	14.32	27.57	46.44	25.91	164.36	27.39
13.1.1	69.70	65.00	66.82	87.20	81.20	113.11	483.03	80.51
TOTAL	282.23	554.16	232.59	363.71	452.10	481.05	2365.84	
MEAN	31.36	61.57	25.84	40.41	50.20	53.45		43.81

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
SITE	5	2440.84	488.17	9.69^{**}	0.0001
REPLICATION WITHIN SITE	12	233.40	19.45	0.39^{ns}	0.9657
ACCESSION	8	889.61	111.20	2.21^{*}	0.0334
SITE*ACCESSION	40	1947.44	48.69	0.97^{ns}	0.5368
ERROR	96	45945.79	478.60		
TOTAL	161	159144.77			

R-square = 0.71
Coefficient of Variance (CV) = 49.94%

Appendix Table 3. Dry matter content

PRODUCTION SITE	POTATO ACCESSION	REPLICATION I	II	III	TOTAL	MEAN
ENLANDAD	380251.17	30.00	26.00	17.00	73.00	24.33
	676070	15.00	15.50	15.50	46.00	15.33
	Ganza	15.50	16.50	28.00	60.00	20.00
	285411.22	21.50	18.50	14.00	54.00	18.00
	573275	24.00	22.50	21.50	68.00	22.67
	676089	20.00	19.00	18.00	57.00	19.00
	5.19.2.2	18.50	21.00	30.00	69.50	23.17
	575003	16.50	16.00	17.00	49.50	16.50
	13.1.1	20.00	21.50	24.50	66.00	22.00
LONGLONG	380251.17	17.50	17.50	17.50	52.50	17.50
	676070	20.50	22.00	21.00	63.50	21.17
	Ganza	19.00	19.50	19.50	58.00	19.33
	285411.22	22.00	18.50	19.50	60.00	20.00
	573275	20.00	20.00	19.00	59.00	19.67
	676089	23.50	23.50	23.50	70.50	23.50
	5.19.2.2	21.00	20.00	17.50	58.50	19.50
	575003	18.50	19.00	19.50	57.00	19.00
	13.1.1	18.50	19.50	18.00	56.00	18.67
SINIPSIP	380251.17	16.50	16.50	17.00	50.00	16.67
	676070	15.50	16.00	16.00	47.50	15.83
	Ganza	17.00	17.00	17.00	51.00	17.00
	285411.22	17.00	17.00	18.00	52.00	17.33
	573275	17.00	16.50	15.50	49.00	16.33
	676089	17.00	17.50	17.50	52.00	17.33
	5.19.2.2	19.00	19.00	19.50	57.50	19.17
	575003	17.50	18.00	18.00	53.50	17.83
	13.1.1	19.00	20.00	19.00	58.00	19.33
LOO	380251.17	17.00	17.00	17.00	51.00	17.00
	676070	17.00	18.00	17.50	52.50	17.50
	Ganza	17.00	17.00	17.00	51.00	17.00

Appendix Table 3. continued …

PRODUCTION SITE	POTATO ACCESSION	REPLICATION I	II	III	TOTAL	MEAN
LOO	285411.22	16.50	16.50	17.00	50.00	16.67
	573275	21.00	21.00	21.00	63.00	21.00
	676089	19.00	19.50	19.00	57.50	19.17
	5.19.2.2	20.00	20.00	19.50	59.50	19.83
	575003	18.50	19.50	19.00	57.00	19.00
	13.1.1	20.00	21.50	22.00	63.50	21.17
BALILI	380251.17	18.00	18.50	18.50	55.00	18.33
	676070	21.50	21.50	22.00	65.00	21.67
	Ganza	19.00	21.00	19.50	59.50	19.83
	285411.22	19.50	20.00	20.00	59.50	19.83
	573275	20.50	21.00	21.00	62.50	20.83
	676089	21.00	26.50	22.50	70.00	23.33
	5.19.2.2	21.50	20.50	20.50	62.50	20.83
	575003	21.50	22.50	22.50	66.50	22.17
	13.1.1	19.50	20.00	21.00	60.50	20.17
CABUTOTAN	380251.17	18.50	17.50	17.50	53.50	17.83
	676070	17.00	16.00	16.50	49.50	16.50
	Ganza	17.50	17.00	17.86	52.36	17.45
	285411.22	18.50	18.50	19.00	56.00	18.67
	573275	19.00	21.50	20.50	61.00	20.33
	676089	21.00	21.00	22.00	64.00	21.33
	5.19.2.2	19.50	21.00	20.50	61.00	20.33
	575003	20.50	19.50	19.50	59.50	19.83
	13.1.1	17.50	20.00	19.00	56.50	18.83

TWO – WAY TABLE

ACCE-SSION	ENGLAN-DAD	LONG-LONG	SINIP-SIP	LOO	BALILI	CABUTO-TAN	TOTAL	MEAN
380251.17	24.33	17.50	16.67	17.00	18.33	17.83	111.66	18.61
676070	15.33	21.17	15.83	17.50	21.67	16.50	108.00	18.00
Ganza	20.00	19.33	17.00	17.00	19.83	17.45	110.61	18.44
285411.22	18.00	20.00	17.33	16.67	19.83	18.67	110.50	18.42
573275	22.67	19.67	16.33	21.00	20.83	20.33	120.83	20.14
676089	19.00	23.50	17.33	19.17	23.33	21.33	123.66	20.62
5.19.2.2	23.17	19.50	19.17	19.83	20.83	20.33	122.83	20.47
575003	16.50	19.00	17.83	19.00	22.17	19.83	114.33	19.08
13.1.1	22.00	18.67	19.33	21.17	20.17	18.83	120.17	20.03
TOTAL	181.00	178.34	156.82	168.34	186.99	171.10	1042.59	
MEAN	20.11	19.83	17.42	18.70	20.78	19.01		19.31

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
SITE	5	191.01	38.20	33.61^{**}	0.0001
REPLICATION WITHIN SITE	12	13.64	1.14	0.32^{ns}	0.9850
ACCESSION	8	145.06	18.13	5.04^{**}	0.0001
SITE*ACCESSION	40	378.64	9.47	2.63^{**}	0.0001
ERROR	96	345.44	3.60		
TOTAL	161	1073.78			

R-square = 0.68
Coefficient of Variance (CV) = 9.82%

Appendix Table 4. Specific gravity

PRODUCTION SITE	POTATO ACCESSION	REPLICATION I	II	III	TOTAL	MEAN
ENLANDAD	380251.17	1.260	1.060	1.058	3.378	1.126
	676070	1.048	1.050	1.050	3.148	1.049
	Ganza	1.050	1.050	1.160	3.260	1.087
	285411.22	1.082	1.066	1.043	3.191	1.064
	573275	1.096	1.087	1.082	3.265	1.088
	676089	1.074	1.067	1.064	3.205	1.068
	5.19.2.2	1.066	1.079	1.260	3.405	1.135
	575003	1.056	1.053	1.058	3.167	1.056
	13.1.1	1.074	1.082	1.098	3.254	1.084
LONGLONG	380251.17	1.061	1.060	1.060	3.181	1.060
	676070	1.076	1.085	1.079	3.240	1.080
	Ganza	1.069	1.071	1.071	3.211	1.070
	285411.22	1.085	1.066	1.071	3.222	1.074
	573275	1.074	1.074	1.069	3.217	1.072
	676089	1.093	1.093	1.093	3.279	1.093
	5.19.2.2	1.079	1.074	1.060	3.213	1.071
	575003	1.066	1.069	1.071	3.206	1.069
	13.1.1	1.066	1.071	1.064	3.201	1.067
SINIPSIP	380251.17	1.055	1.055	1.058	3.168	1.056
	676070	1.050	1.053	1.053	3.156	1.052
	Ganza	1.058	1.058	1.058	3.174	1.058
	285411.22	1.058	1.058	1.064	3.180	1.060
	573275	1.058	1.055	1.050	3.163	1.054
	676089	1.058	1.060	1.060	3.178	1.059
	5.19.2.2	1.069	1.069	1.071	3.209	1.070
	575003	1.060	1.064	1.064	3.188	1.063
	13.1.1	1.069	1.074	1.069	3.212	1.071
LOO	380251.17	1.058	1.058	1.058	3.174	1.058
	676070	1.058	1.064	1.060	3.182	1.061
	Ganza	1.058	1.058	1.058	3.174	1.058

Appendix Table 4. continued …

PRODUCTION SITE	POTATO ACCESSION	REPLICATION I	II	III	TOTAL	MEAN
LOO	285411.22	1.055	1.055	1.058	3.168	1.056
	573275	1.079	1.079	1.079	3.237	1.079
	676089	1.069	1.071	1.069	3.209	1.070
	5.19.2.2	1.074	1.074	1.071	3.219	1.073
	575003	1.066	1.071	1.069	3.206	1.069
	13.1.1	1.074	1.082	1.085	3.241	1.080
BALILI	380251.17	1.064	1.066	1.066	3.196	1.066
	676070	1.082	1.082	1.085	3.249	1.083
	Ganza	1.069	1.079	1.071	3.219	1.073
	285411.22	1.071	1.074	1.074	3.219	1.073
	573275	1.076	1.079	1.079	3.234	1.078
	676089	1.079	1.080	1.087	3.246	1.082
	5.19.2.2	1.082	1.076	1.076	3.234	1.078
	575003	1.082	1.087	1.087	3.256	1.085
	13.1.1	1.071	1.074	1.079	3.224	1.075
CABUTOTAN	380251.17	1.066	1.060	1.060	3.186	1.062
	676070	1.058	1.053	1.055	3.166	1.055
	Ganza	1.060	1.058	1.063	3.181	1.060
	285411.22	1.066	1.066	1.069	3.201	1.067
	573275	1.069	1.082	1.076	3.227	1.076
	676089	1.079	1.079	1.085	3.243	1.081
	5.19.2.2	1.071	1.079	1.076	3.226	1.075
	575003	1.076	1.071	1.071	3.218	1.073
	13.1.1	1.060	1.074	1.069	3.203	1.067

TWO – WAY TABLE

ACCE-SSION	ENGLAN-DAD	LONG-LONG	SINIP-SIP	LOO	BALILI	CABUTO-TAN	TOTAL	MEAN
380251.17	1.13	1.06	1.06	1.06	1.07	1.06	6.44	1.071
676070	1.05	1.08	1.05	1.06	1.08	1.06	6.38	1.063
Ganza	1.09	1.07	1.06	1.06	1.07	1.06	6.41	1.068
285411.22	1.07	1.07	1.06	1.06	1.07	1.07	6.40	1.066
573275	1.09	1.07	1.05	1.08	1.08	1.08	6.45	1.075
676089	1.07	1.09	1.06	1.07	1.08	1.08	6.45	1.076
5.19.2.2	1.14	1.07	1.07	1.07	1.08	1.08	6.51	1.084
575003	1.06	1.07	1.06	1.07	1.09	1.07	6.42	1.069
13.1.1	1.08	1.07	1.07	1.08	1.07	1.07	6.44	1.074
TOTAL	9.78	9.65	9.54	9.61	9.69	9.63	57.90	
MEAN	1.084	1.073	1.060	1.067	1.077	1.069		1.072

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
SITE	5	191.01	38.20	33.61^{**}	0.0001
REPLICATION WITHIN SITE	12	13.64	1.14	0.32^{ns}	0.9850
ACCESSION	8	145.06	18.13	5.04^{**}	0.0001
SITE*ACCESSION	40	378.64	9.47	2.63^{**}	0.0001
ERROR	96	345.44	3.60		
TOTAL	161	1073.78			

R-square = 0.43
Coefficient of Variance (CV) = 2.26%

Appendix Table 5. Sugar content

PRODUCTION SITE	POTATO ACCESSION	REPLICATION I	II	III	TOTAL	MEAN
ENLANDAD	380251.17	3.20	4.20	3.00	10.40	3.50
	676070	4.50	4.30	3.00	11.80	3.90
	Ganza	5.00	5.40	4.50	14.90	5.00
	285411.22	4.50	4.00	5.20	13.70	4.60
	573275	4.10	4.10	4.60	12.80	4.30
	676089	4.40	3.40	3.20	11.00	3.70
	5.19.2.2	4.00	4.10	3.70	11.80	3.90
	575003	3.50	4.80	4.20	12.50	4.20
	13.1.1	4.30	4.40	4.60	13.30	4.40
LONGLONG	380251.17	2.80	3.40	3.20	9.40	3.10
	676070	4.00	5.60	6.40	16.00	5.30
	Ganza	4.10	3.40	4.00	11.50	3.80
	285411.22	3.80	4.60	4.40	12.80	4.30
	573275	3.90	4.80	4.80	13.50	4.50
	676089	3.60	4.30	3.80	11.70	3.90
	5.19.2.2	3.50	5.80	4.80	14.10	4.70
	575003	5.90	4.40	4.30	14.60	4.90
	13.1.1	3.90	4.30	4.50	12.70	4.20
SINIPSIP	380251.17	4.20	2.90	4.10	11.20	3.70
	676070	4.90	4.10	4.30	13.30	4.40
	Ganza	2.80	4.20	3.70	10.70	3.60
	285411.22	3.20	3.20	2.60	9.00	3.00
	573275	3.30	2.90	4.70	10.90	3.60
	676089	2.80	3.20	2.20	8.20	2.70
	5.19.2.2	3.30	4.20	3.20	10.70	3.60
	575003	3.60	4.40	4.00	12.00	4.00
	13.1.1	3.70	3.40	2.70	9.80	3.30
LOO	380251.17	4.00	3.90	4.10	12.00	4.00
	676070	5.90	4.00	5.40	15.30	5.10
	Ganza	4.60	3.70	4.40	12.70	4.20

Appendix Table 5. continued …

PRODUCTION SITE	POTATO ACCESSION	REPLICATION I	II	III	TOTAL	MEAN
LOO	285411.22	4.10	4.30	5.10	13.50	4.50
	573275	4.10	3.20	3.90	11.20	3.70
	676089	7.60	4.40	3.70	15.70	5.20
	5.19.2.2	3.30	4.30	2.80	10.40	3.50
	575003	4.30	3.90	6.00	14.20	4.70
	13.1.1	5.10	4.10	4.10	13.30	4.40
BALILI	380251.17	4.70	4.00	4.00	12.70	4.20
	676070	2.40	4.50	2.40	9.30	3.10
	Ganza	3.90	3.60	4.40	11.90	4.00
	285411.22	4.20	1.90	3.90	10.00	3.30
	573275	3.90	3.80	4.30	12.00	4.00
	676089	4.30	3.70	5.00	13.00	4.30
	5.19.2.2	4.70	3.90	5.00	13.60	4.50
	575003	4.20	3.90	3.90	12.00	4.00
	13.1.1	3.60	4.40	4.00	12.00	4.00
CABUTOTAN	380251.17	4.10	3.20	3.90	11.20	3.70
	676070	3.90	3.90	3.70	11.50	3.80
	Ganza	4.40	3.20	3.90	11.50	3.80
	285411.22	2.60	3.40	4.10	10.10	3.40
	573275	4.10	3.90	3.80	11.80	3.90
	676089	4.20	3.60	3.80	11.60	3.90
	5.19.2.2	3.80	3.50	2.50	9.80	3.30
	575003	4.70	4.70	4.70	14.10	4.70
	13.1.1	2.30	2.70	3.80	8.80	2.90

TWO – WAY TABLE

ACCE-SSION	ENGLAN-DAD	LONG-LONG	SINIP-SIP	LOO	BALILI	CABUTO-TAN	TOTAL	MEAN
380251.17	3.50	3.10	3.70	4.00	4.20	3.70	22.20	3.72
676070	3.90	5.30	4.40	5.10	3.10	3.80	25.60	4.29
Ganza	5.00	3.80	3.60	4.20	4.00	3.80	24.40	4.07
285411.22	4.60	4.30	3.00	4.50	3.30	3.40	23.10	3.84
573275	4.30	4.50	3.60	3.70	4.00	3.90	24.00	4.01
676089	3.70	3.90	2.70	5.20	4.30	3.90	23.70	3.96
5.19.2.2	3.90	4.70	3.60	3.50	4.50	3.30	23.50	3.91
575003	4.20	4.90	4.00	4.70	4.00	4.70	26.50	4.41
13.1.1	4.40	4.20	3.30	4.40	4.00	2.90	23.20	3.88
TOTAL	37.50	38.70	31.90	39.30	35.40	33.40	216.20	
MEAN	4.16	4.31	3.55	4.38	3.94	3.72		4.00

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
SITE	5	14.86	2.97	5.90^{**}	0.0056
REPLICATION WITHIN SITE	12	6.04	0.50	1.09^{ns}	0.3801
ACCESSION	8	6.95	0.87	1.87^{ns}	0.0728
SITE*ACCESSION	40	33.92	0.85	1.83^{**}	0.0086
ERROR	96	44.47	0.46		
TOTAL	161	106.24			

R-square = 0.58
Coefficient of Variance (CV) = 16.98%

Appendix Table 6. Chip recovery

PRODUCTION SITE	POTATO ACCESSION	REPLICATION I	II	III	TOTAL	MEAN
ENLANDAD	380251.17	89.50	93.00	81.30	263.80	87.93
	676070	76.90	84.30	83.50	244.70	81.57
	Ganza	80.70	71.20	70.40	222.30	74.10
	285411.22	76.50	84.10	79.00	239.60	79.87
	573275	72.80	86.80	69.00	228.60	76.20
	676089	---	---	---	---	---
	5.19.2.2	98.70	74.30	75.30	248.30	82.77
	575003	81.70	96.30	72.80	250.80	83.60
	13.1.1	79.00	80.30	76.50	235.80	78.60
LONGLONG	380251.17	80.80	75.20	79.70	235.70	78.57
	676070	78.80	76.80	81.00	236.60	78.87
	Ganza	89.30	83.70	78.30	251.30	83.77
	285411.22	66.60	74.80	70.40	211.80	70.60
	573275	88.20	81.80	87.10	257.10	85.70
	676089	88.40	88.90	84.10	261.40	87.13
	5.19.2.2	77.90	82.50	44.30	204.70	68.23
	575003	77.20	73.80	57.60	208.60	69.53
	13.1.1	77.90	74.90	75.90	228.70	76.23
SINIPSIP	380251.17	80.60	78.40	75.70	234.70	78.23
	676070	85.70	74.10	89.10	248.90	82.97
	Ganza	78.40	68.90	71.30	218.60	72.87
	285411.22	66.50	30.30	65.30	162.10	54.03
	573275	---	57.10	76.50	---	---
	676089	62.20	73.50	50.60	186.30	62.10
	5.19.2.2	81.20	69.30	68.70	219.20	73.07
	575003	61.90	69.10	59.50	190.50	63.50
	13.1.1	73.40	66.20	82.50	222.10	74.03
LOO	380251.17	75.10	73.30	72.20	220.60	73.53
	676070	69.70	85.50	92.50	247.70	82.57
	Ganza	72.70	76.60	71.80	221.10	73.70

Appendix Table 6. continued …

PRODUCTION SITE	POTATO ACCESSION	REPLICATION I	II	III	TOTAL	MEAN
LOO	285411.22	64.20	72.50	71.80	208.50	69.50
	573275	66.90	79.70	87.30	233.90	77.97
	676089	80.10	79.60	80.30	240.00	80.00
	5.19.2.2	81.60	81.10	72.60	235.30	78.43
	575003	72.40	80.60	66.10	219.10	73.03
	13.1.1	81.10	79.80	81.60	242.50	80.83
BALILI	380251.17	82.90	85.60	82.00	250.50	83.50
	676070	81.70	81.60	84.20	247.50	82.50
	Ganza	82.90	81.70	80.10	244.70	81.57
	285411.22	71.80	78.80	70.50	221.10	73.70
	573275	83.10	83.90	85.00	252.00	84.00
	676089	89.40	90.00	86.60	266.00	88.67
	5.19.2.2	83.30	83.60	86.90	253.80	84.60
	575003	82.30	87.20	82.20	251.70	83.90
	13.1.1	88.00	72.30	86.40	246.70	82.23
CABUTOTAN	380251.17	86.50	90.00	83.60	260.10	86.70
	676070	85.50	84.40	76.80	246.70	82.23
	Ganza	79.10	84.40	83.30	246.80	82.27
	285411.22	77.70	71.80	66.30	215.80	71.93
	573275	84.20	85.90	86.50	256.60	85.53
	676089	84.70	79.40	82.70	246.80	82.27
	5.19.2.2	82.40	81.80	88.70	252.90	84.30
	575003	73.30	77.50	76.40	227.20	75.73
	13.1.1	77.40	77.20	74.80	229.40	76.47

TWO – WAY TABLE

ACCE-SSION	ENGLAN-DAD	LONG-LONG	SINIP-SIP	LOO	BALILI	CABUTO-TAN	TOTAL	MEAN
380251.17	87.93	78.57	78.23	73.53	83.50	86.70	488.46	81.41
676070	81.57	78.87	82.97	82.57	82.50	82.23	490.71	81.78
Ganza	74.10	83.77	72.87	73.70	81.57	82.27	468.28	78.04
285411.22	79.87	70.60	54.03	69.50	73.70	71.93	419.63	69.94
573275	76.20	85.70	66.80	77.97	84.00	85.53	476.20	80.11
676089	---	87.13	62.10	80.00	88.67	82.27	400.17	80.03
5.19.2.2	82.77	68.23	73.07	78.43	84.60	84.30	471.40	78.57
575003	83.60	69.53	63.50	73.03	83.90	75.73	449.29	74.88
13.1.1	78.60	76.23	74.03	80.83	82.23	76.47	468.39	78.07
TOTAL	644.64	698.63	627.60	689.56	744.67	727.43	4132.53	
MEAN	80.58	77.63	69.85	76.62	82.74	80.83		76.53

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
SITE	5	2765.71	553.14	6.61**	0.0036
REPLICATION WITHIN SITE	12	1004.39	83.70	1.85*	0.0510
ACCESSION	8	1954.61	244.33	5.40**	0.0001
SITE*ACCESSION	39	2986.24	76.57	1.69*	0.0205
ERROR	93	4204.93	45.21		
TOTAL	157	12915.89			

R-square = 0.67
Coefficient of Variance (CV) = 8.62%

Appendix Table 7. Chip color

PRODUCTION SITE	POTATO ACCESSION	REPLICATION I	II	III	TOTAL	MEAN
ENLANDAD	380251.17	4.00	4.00	3.00	11.00	3.67
	676070	4.00	4.00	4.00	12.00	4.00
	Ganza	4.00	4.00	3.00	11.00	3.67
	285411.22	4.00	4.00	3.00	11.00	3.67
	573275	4.00	4.00	5.00	13.00	4.33
	676089	3.00	3.00	3.00	9.00	3.00
	5.19.2.2	3.00	4.00	4.00	11.00	3.67
	575003	4.00	4.00	3.00	11.00	3.67
	13.1.1	4.00	3.00	3.00	10.00	3.33
LONGLONG	380251.17	3.00	3.00	3.00	9.00	3.00
	676070	4.00	4.00	4.00	12.00	4.00
	Ganza	4.00	3.00	3.00	10.00	3.33
	285411.22	3.00	3.00	3.00	9.00	3.00
	573275	3.00	3.00	3.00	9.00	3.00
	676089	3.00	3.00	3.00	9.00	3.00
	5.19.2.2	4.00	3.00	3.00	10.00	3.33
	575003	4.00	4.00	4.00	12.00	4.00
	13.1.1	3.00	3.00	3.00	9.00	3.00
SINIPSIP	380251.17	3.00	3.00	3.00	9.00	3.00
	676070	6.00	4.00	4.00	14.00	4.67
	Ganza	4.00	3.00	3.00	10.00	3.33
	285411.22	3.00	4.00	4.00	11.00	3.67
	573275	5.00	4.00	4.00	13.00	4.33
	676089	3.00	3.00	3.00	9.00	3.00
	5.19.2.2	3.00	3.00	3.00	9.00	3.00
	575003	4.00	4.00	3.00	11.00	3.67
	13.1.1	3.00	3.00	4.00	10.00	3.33
LOO	380251.17	4.00	4.00	4.00	12.00	4.00
	676070	4.00	4.00	3.00	11.00	3.67
	Ganza	4.00	4.00	4.00	12.00	4.00

Appendix Table 7. continued …

PRODUCTION SITE	POTATO ACCESSION	REPLICATION I	II	III	TOTAL	MEAN
LOO	285411.22	4.00	4.00	3.00	11.00	3.67
	573275	3.00	3.00	4.00	10.00	3.33
	676089	4.00	4.00	3.00	11.00	3.67
	5.19.2.2	3.00	3.00	3.00	9.00	3.00
	575003	3.00	3.00	3.00	9.00	3.00
	13.1.1	3.00	3.00	4.00	10.00	3.33
BALILI	380251.17	3.00	3.00	3.00	9.00	3.00
	676070	3.00	4.00	3.00	10.00	3.33
	Ganza	4.00	3.00	3.00	10.00	3.33
	285411.22	3.00	4.00	3.00	10.00	3.33
	573275	4.00	3.00	4.00	11.00	3.67
	676089	3.00	3.00	3.00	9.00	3.00
	5.19.2.2	4.00	4.00	3.00	11.00	3.67
	575003	4.00	3.00	4.00	11.00	3.67
	13.1.1	4.00	3.00	4.00	11.00	3.67
CABUTOTAN	380251.17	3.00	3.00	4.00	10.00	3.33
	676070	3.00	3.00	4.00	10.00	3.33
	Ganza	3.00	4.00	3.00	10.00	3.33
	285411.22	3.00	4.00	3.00	10.00	3.33
	573275	3.00	3.00	3.00	9.00	3.00
	676089	3.00	3.00	4.00	10.00	3.33
	5.19.2.2	3.00	3.00	3.00	9.00	3.00
	575003	4.00	3.00	3.00	10.00	3.33
	13.1.1	3.00	4.00	3.00	10.00	3.33

TWO – WAY TABLE

ACCE-SSION	ENGLAN-DAD	LONG-LONG	SINIP-SIP	LOO	BALILI	CABUTO-TAN	TOTAL	MEAN
380251.17	4.00	3.00	3.00	4.00	3.00	3.00	20.00	3.00
676070	4.00	4.00	5.00	4.00	3.00	3.00	23.00	4.00
Ganza	4.00	3.00	3.00	4.00	3.00	3.00	21.00	4.00
285411.22	4.00	3.00	4.00	4.00	3.00	3.00	20.00	3.00
573275	4.00	3.00	4.00	3.00	4.00	3.00	21.00	4.00
676089	3.00	3.00	3.00	4.00	3.00	3.00	19.00	3.00
5.19.2.2	4.00	3.00	3.00	3.00	4.00	3.00	20.00	3.00
575003	4.00	4.00	4.00	3.00	4.00	3.00	22.00	4.00
13.1.1	3.00	3.00	3.00	3.00	4.00	3.00	19.00	3.00
TOTAL	34.00	29.00	32.00	32.00	31.00	27.00	185.00	
MEAN	4.00	3.00	4.00	4.00	3.00	3.00		3.00

ANALYSIS OF VARIANCE

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
SITE	5	3.36	0.67	3.52^{*}	0.0345
REPLICATION WITHIN SITE	12	2.30	0.19	0.82^{ns}	0.6283
ACCESSION	8	5.83	0.73	3.13^{**}	0.0035
SITE*ACCESSION	40	16.25	0.41	1.74^{*}	0.0144
ERROR	96	22.37	0.23		
TOTAL	161	50.10			

R-square = 0.55
Coefficient of Variance (CV) = 13.99%

Appendix Table 8. Conversion table for potato dry matter and specific gravity

DMC	SG	DMC	SG	DMC	SG
14.0	1.043	17.9	1.063	21.7	1.083
14.2	1.044	18.1	1.064	21.8	1.084
14.4	1.045	18.3	1.065	22.0	1.085
14.6	1.046	18.5	1.066	22.2	1.086
14.8	1.047	18.7	1.067	22.4	1.087
15.0	1.048	18.9	1.068	22.6	1.088
15.2	1.049	19.0	1.069	22.8	1.089
15.4	1.050	19.2	1.070	23.0	1.090
15.6	1.051	19.4	1.071	23.1	1.091
15.8	1.052	19.6	1.072	23.3	1.092
16.0	1.053	19.8	1.073	23.5	1.093
16.2	1.054	20.0	1.074	23.7	1.094
16.4	1.055	20.2	1.075	23.9	1.095
16.6	1.056	20.4	1.076	24.1	1.096
16.8	1.057	20.6	1.077	24.3	1.097
17.0	1.058	20.8	1.078	24.5	1.098
17.2	1.059	21.0	1.079	24.7	1.099
17.4	1.060	21.2	1.080	24.9	1.100
17.6	1.061	21.3	1.081		
17.8	1.062	21.5	1.082		

Source: Kellock, 1995

Appendix 9. Tuber skin color (www.cip.cgiar.research.org)

Yellowish

Brownish

Pink and purplish around eyes

Purplish red

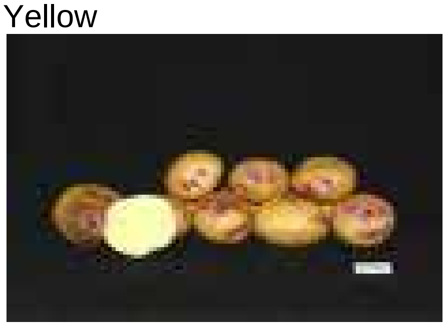
Appendix 10. Tuber flesh color (www.cip.cgiar.research.org)

White

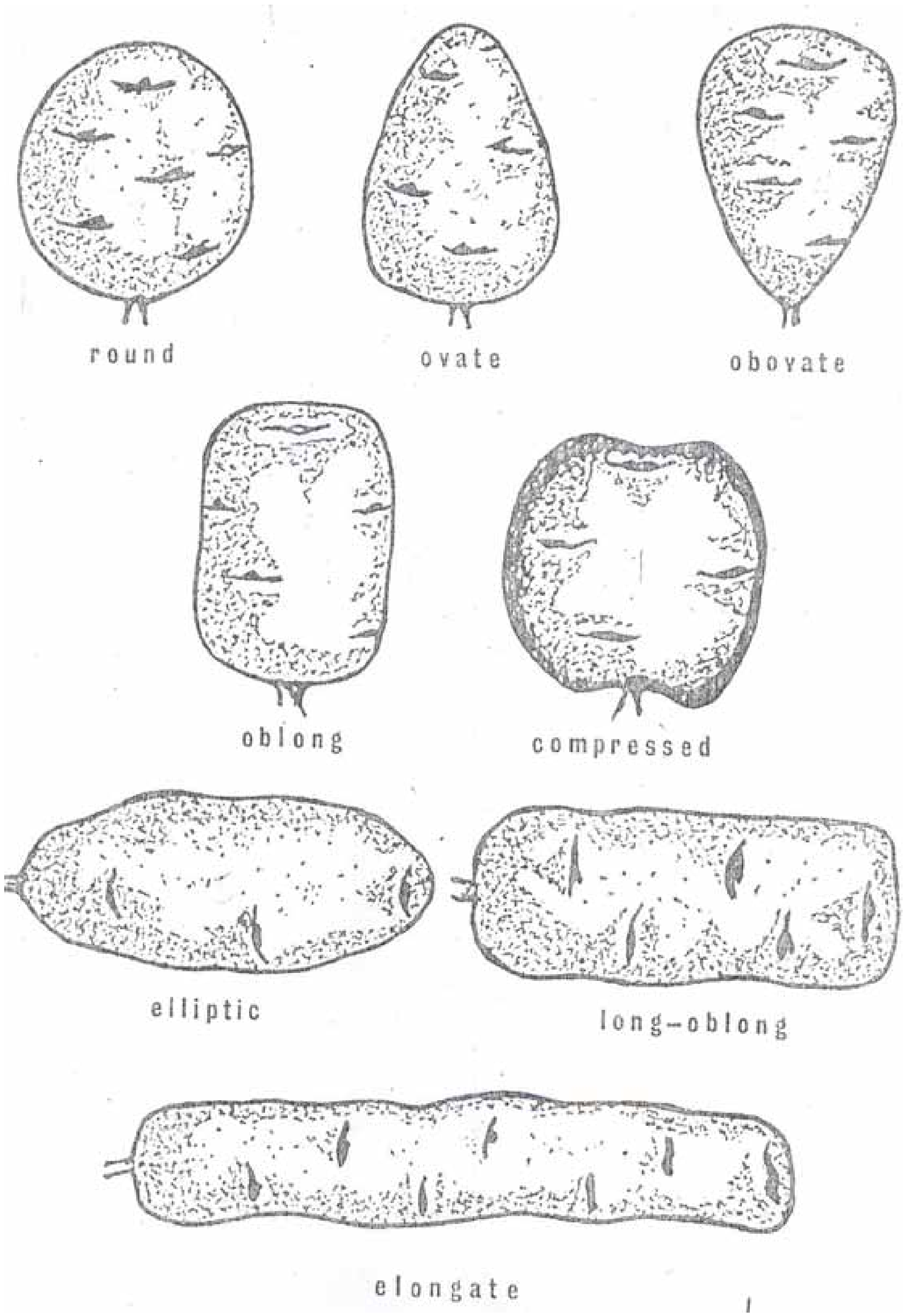
Cream

Pale yellow

Yellow



Appendix 11. General tuber shape (CIP, 1977)



BIOGRAPHICAL SKETCH

The author was born to Ambrose Sagalla and Lily Sagalla on October 14, 1980. She is the third of four daughters.

Following family tradition, she finished her elementary education at Easter School, Guisad, Baguio City. She then went to Benguet State University to finish high school under the Agricultural Science curriculum. She continued her studies in the same university and finished Bachelor of Science in Agriculture major in Agronomy.

In August 2001, three months after graduation, she was employed as a research assistant in one of the foreign funded projects at Northern Philippines Root Crops Research and Training Center (NPRCRTC). After six months of working as a research assistant, she resigned to work at the Department of Agriculture CHARM Project (DA-CHARMP) as an enumerator. She then went back to NPRCRTC under a different project funded by a Korean. She worked on the processing of purple yams for 8 months.

Finally, she was hired on January 2003 as an instructor under the Department of Agronomy, College of Agriculture. She is currently teaching basic and major subjects in Agronomy.