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ECONOMIC MODELS RELATED TO SAP COCONUT PRODUCTION AND MARKETING IN VIETNAM

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ABSTRACT

This study analyses the normal Sap coconut and embryo cultured Sap coconut models as the priority subjects on researching crop varieties adapted to drought. The data used were a large number method with models of normal and embryo cultured Sap coconut in Tra Vinh province. There was no difference between the two models as regard the average roughage time of 3.6 years. The stable age ranged from 5.6 to 5.9 years after growing with an average yield of 47 fruits per tree yearly. The investment cost for embryo cultured Sap coconut model is 2.5 times higher than that of conventional normal Sap coconut model , while the average profit is 3.9 times higher than the Sap coconut. The profit of normal Sap coconut was closely related to the number of mutant fruits/ha/year and selling price and the profit embryo cultured Sap coconut model was strongly affected by total mutant fruits/ha/year factor. There are many factors that affect the rate of copra per bunch such as the dry season and specialized planting, but the variety is an important factor that determines the copra properties of coconut and planting coconut varieties. Transplanting copra embryos for copra ratio reaches 97% during intensive cultivation. Copra production usually reaches 27% and shown only when the fruit is 11 months old. The factors that determine the quality of copra, including the dry season, varieties, organic fertilizer, and early or late harvesting, all affect the quality and thickness of copra

KEYWORDS- Normal Sap coconut, embryo cultured Sap coconut, Makapuno, Tra Vinh province.

1. INTRODUCTION

The coconut (*Cocos nucifera* L.) (Palmae: Arecaceae, monocotyledons) is an economically important crop for many tropical and sub-tropical regions, with the endosperm being one of its main products. The coconut plant is monoecious, with both the male and female flowers growing on the same tree. In the Mekong delta of Vietnam, there is a coconut variety called *Sap* coconut or Makapuno. The '*Sap* coconut*'* is a natural coconut cultivar with an over-proliferating solid endosperm. *Sap* nut, a mutant coconut, is produced on palms along with normal nuts. The *Sap* coconut is a special type of coconut in which the meat almost fills partially or completely the nut water cavity of the shell with a soft, extra-thick kernel (Torres, 1937). Such a fruit does not germinate. Of the 93 countries growing coconut in the world, the coconut group has a thick, soft endosperm, dense and highly nutritious coconut water (intestinal dense coconut) grown in nine (9) countries. *Sap* coconut has different names. It is known as *Dong kathi* in Cambodia, *Thairu tengai* in India, *Kelapa kopyor* in Indonesia and Malaysia, *Moon Makan* in Papua New Guinea, *Makapuno* in Philippines, *Dikiri pol* in Sri LanKa, *Maprao kathi* in Thailand, and *Sap* coconut or Ice Cream Coconut in Vietnam.

Balasubramanian et al. (1976) reported that the normal endosperm has large amounts of galactomanans, while *Sap* coconut has five times the galactomanman content in normal coconut, which has the feature characteristics such as soft, fluffy endosperm and arid viscous liquid (Angela and Mendoza, 1993). In addition, the *Sap* coconut contains higher levels of fatty acids than normal coconuts such as caproic (C_6), 0.61% compared to 0.41%; capric (C_{10}), 7.3% compared to 7.2%; lauric acid (C_{12}), 50% compared to 48% and myristic (C_{14}), 18% compared to 15%, respectively (Duong, 2013). *Sap* coconut products are currently used in food, cosmetics and pharmaceuticals.

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Abraham et al. (1965) reported that the initial stage of development of the *Makapuno* endosperm are similar to those in the normal coconuts. In relation to *Sap* coconut, the endosperm character is believed to be controlled by a recessive (m) gene and expressed as a homozygous condition (mmm) receiving 50% from the father and 50% from the mother (Ismail et al. 2013, Zuniga, 1953).

Copra contains a homozygous recombinant gene that never germinates into a plant. Abraham et al. (1965) showed that the embryo grows as other normal coconut but never germinates to become plant in the natural condition. The Makapuno embryo appears to be morphologically normal, but fails to germinate due to biochemical and physical features of the extraordinary endosperm that is unable to support its germination. The non-germinability of the embryo of *Sap* coconut was believed to be due to the failure of the haustorium to develop, thereby losing the connection between the viable embryo and abnormal endosperm (Cruz, and Ramirez, 1966). In growing normal *Sap* coconut, it must be propagated from fruit in the bunches having one *Sap* coconut fruit (normal *Sap* coconut). The results of these models shows that *Sap* fruit has a ratio ≤ 25% (Long, 2007), flexible ranging from 15 to 18% for extensive growth areas, and 7.5 to 13% for other areas (Thuy, 2008). There is usually 25% *Sap* coconut fruit if the coconut trees are planted by seedlings from parent Sap coconut (Cedo et al. 1984, Islam, 2013). Presently, researchers apply the *in vitro* technique to rescue dead embryos of the *Sap* coconut and create the seedlings by maintaining a homozygous recessive gene (embryo cultured Sap coconut). Embryo cultured *Sap* coconut seedlings were planted in gardens to create mutating fruit about 85% (flexible from 50 to 100%) (De Guzman, and Del Rosario, 1964, De Guzman, and Manuel, 1977) and in Indonesia, same results obtained with 75% (Ismail, 2013). *Sap* coconut is one of the coconut species with high economic value in Vietnam. At present, *Sap* coconut is considered a specialty tree of Tra Vinh province. The price of *Sap* fruit in the garden ranges from 80,000 to 150,000 VND per fruit, which sometimes increases from 160,000 to 170,000 VND per fruit in festive seasons, and 15 to 30 times higher than coconut. According to statistics in 2017, *Sap* coconut was multiplied by the traditional method in Cau Ke district with over 15,000 trees, the number of fruits is about 6,000, and the yield is about 40 to 80 fruits per tree yearly, while the proportion of *Sap* coconut ranged from 25 to 30% (Department of Agriculture and Rural Development of Tra Vinh, 2018). The embryo cultured *Sap* coconut seedling trees were created and grown in Tra Vinh since 2008. According to the research team, until 2019, Tra Vinh have been building seven (7) models of embryo cultured *Sap* coconut with acreage ranging from 0.5 to 1.5 ha per model with the rate of mutating fruit per bunch being ≥ 80%.

Farmers who planted Sap coconuts believed that the soil has effect on the development and composition of copra in the *Sap* coconuts. *Sap* coconuts in Cau Ke planted in other localities showed the percentage of copra and copra composition in *Sap* coconuts have a negative change. It means that the percentage rate of copra was lesser and fatness decreased, including the taste of the copra. In order to reinforce the scientific basis in deploying and replicating the model of *Sap* coconuts, especially the embryo cultured *Sap* coconuts, the project "Economic Models Related to *Sap* Coconut Production and Marketing in Vietnam." was carried out.

2. MATERIAL AND METHODS

Material
Secondary data were obtained from the Department of Agriculture and Rural Development, Statistical Office of Tra Vinh Province, Department of Agriculture and Rural Development of Cau Ke District and some documents related to the research subjects.

Data collection method
Primary data were obtained through observation and direct interviews with selected respondent farmers using questionnaires. Sample size used a large number method; The project was investigated in 3 communes (20 households per commune) with the largest area of Sap coconuts, including Hoa Tan, Tam Ngai and Cau Ke town, Cau Ke district. 100% of households grow Sap coconut embryos cultured by transplanting (7 households) in Tra Vinh province.

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Figure 1: Embryo cultured Sap coconuts

Data analysis

Survey data was checked, analyzed, coded, and added into the Microsoft Excel Office 2013 and SPSS program for mathematic and statistic purposes.

- Descriptive statistics

To mathematic and present economic and technical indicators (average, error, standard deviation, minimum value, maximum value, frequency, etc.)

- CRA - Costs and Returns Analysis

In order to determine the financial efficiency of two models of normal *Sap* coconuts and embryo cultured *Sap* coconuts in Tra Vinh province, the ratio of revenue /expense, profit /cost ratio, profit /revenue ratio are included.

- Economic indicators

Total production costs include all labor costs (including hired labor and family opportunity labor), production supplies and basic investment. Daily labor was not as significant as garden visits, etc., so it is not counted. The cost of production materials such as fertilizers, pesticides, fuel and so on. Basic investment costs such as seedling, soil preparation, digging ponds /ditches, machinery, equipment and the like are amortized each year. Other costs related to the interest rate of invested capital and production-related fees are not included.

- Testing hypothesis

Used Independent-Samples T test to compare 02 models. The hypothesis was released

+ H_0: no difference between two models
+ H_1: difference between two models

With a 5% significance level, the deciding principle was:

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+ Denise the hypothesis H_0 if Sig.T < 0.5
+ Accept the hypothesis H_0 if Sig.T > 0.5

- Multivariate linear regression analysis

Used linear multivariate regression analysis to evaluate the affection level of factors on the financial efficiency of households implementing both *Sap* coconut models. Estimate the degree of correlation (correlation) between the independent variables and dependent variables or independent variables (the causative factors).

Step 1: Determining multivariate linear regression models of the form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \ldots + \beta_i X_i + \varepsilon$$

Where:
Y: independent vatiables β_0: Constant
$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5 \ldots \beta_i$ regression coefficients
ε: Randon error
$X_1, X_2, X_3, X_4, X_5, \ldots, X_i$: dependent variables

Step2. From the theoretical multivariate regression model, conduct analysis and propose an estimated regression model of the form:

$$\hat{Y} = a + b_1 X_1 + b_2 X_2 + \ldots + b_n X_n$$

Where
Ŷ: dependent variables
a: content, that showed value of Y variable when $X_1, X_2, \ldots, X_n$ variables equal 0
$X_1, X_2, \ldots, X_n$: dependent variables
$b_1, b_2, \ldots, b_n$: regression coefficients.
In this study, independent and dependent variables were identified as follows:
Ŷ: Profit (without family labors) (1.000 dong/hectare/year).
X_1: Seedling
X_2: Education level
X_3: Ethnics (1. Kinh, 0: Khmer)
X_4: Experience (year)
X_5: Price
X_6: Farm coconut size (hectare)
X_7: Density (trees/hectare)
X_8: Ages of coconut trees (year)
X_9: Total mutant fruits/hectare/year

Table 1: The basis for selecting variables in the regression model

Mark	Declare	Source	Expection
X_1	Seedlings		+
X_2	Household leader's education and coded with its value such as: no education was Zero; 1 to 12 equivalent 1st to 12th grade; vocational equals 14; college was 15; university was 16; and postgraduate was 18-20.	Ngoc (2015), Kiet (2017)	+
X_3	Ethnic	Cuong (2018)	+
X_4	Household leader's experience to take care the coconut gardens years of experience in producing coconuts of the household head	Hong (2017), Kiet (2017)	+
X_5	Price	The authors propose	+

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Mark	Declare	Source	Expection
X_1	Seedlings		+
X_2	Household leader's education and coded with its value such as: no education was Zero; 1 to 12 equivalent 1st to 12th grade; vocational equals 14; college was 15; university was 16; and postgraduate was 18-20.	Ngoc (2015), Kiet (2017)	+
X_3	Ethnic	Cuong (2018)	+
X_6	Acreage. Get a value equal to the number of areas owned by the coconut farming household at the time of the study	Ngoc **Error! Reference source not found.**(2015), Kiet (2017)	+
X_7	Planting density	Cuong (2018)	+
X_8	Years of coconut garden	Cuong (2018)	+
X_9	Total of mutant fruits/hectare/yearly	The authors propose	+

Step 3. Differential regression testing on all regression parameters

General hypothesis:

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 \ldots \beta_i = 0$: All variables did not affect Y.

H_1: At least β_i variable did not equal zero (a variable affect on Y).

Basic on analysis result ANOVA (variance analysis) used F test, if the value was different (Sig F) and the alpha significance level was processed to decide to accept or reject H_0. The conclusion was based on:

If Sig.F > α: accept H_0

If Sig.F < α: reject H_0

If decide to reject H_0, accept H_1, the result of step 3 was used to conclude specifically how many variables affect Y and which variables.

Step 4. Test regression for each separately parameter General hypothesis:

H_0: $\beta_i = 0$: X_i not affect Y

H_1: $\beta_i \neq 0$: X_i affect Y

Based on the probability value (p_value) and the significance level alpha (α = 5%) processed to determine whether each independent variable X_i will affect the rate (%) of the profit of farmer Y or not. The conclusion was based on: If the probability value p of the variable Xi> value α: No effect (accept H_0). If the probability value p of the variable X_i <value α: Influence (reject H_0, accept H_1). This variable X_i is the one that really affects farm household Y profit.

Step 5: Explain the multiple correlation coefficient R (multiple R).

The multiple correlation coefficient R (Multiple R - Multiple correlation coefficient): Indicated the close relationship between the dependent variable Y and the independent variables X_i.

R had value in the range ± 1 ($-1 \leq R \leq +1$).

R = ± 1: There was a close relation between the variables X_i and Y.

Step 6: Explain the coefficient of determination R^2 *(R square)*

Determination coefficient R^2 (R square): The percentage of variation in Y was explained by the independent variables X_i or % of X_i influences Y, the rest due to other factors that we had not studied.

Step 7: Explain the regression results

When the other factors were constant, for every 1 unit increase of X_i, increase /decrease by β_i times the unit of variable Y (depending on the sign β_i before the variable X_i in the equation).

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3. RESULTS AND DISCUSSION

Overview of the cultivation of normal *Sap* coconuts and embryo cultured *Sap* coconuts in Tra Vinh province

Acreage for growing normal Sap coconuts and embryo cultured Sap coconuts of farmers in Tra Vinh province

Table 2 shows that the average acreage of coconut farmers in Tra Vinh province was less than 1.0 ha, accounting for 92%, this result is suitable with (Cuong, 2018) that the scale for cultivating *Sap* coconut was small, so the percentage of *Sap* coconut's fruits per bunch was lower than 20%. The results of T- test also show that there was a difference in average acreage between the two (2) groups of farmers at a significant level of 5% with t = - 0.986. In particular, the area planted with embryo from 0.5 ha or more accounted for 71%, while *Sap* coconut only accounted for 50%. Increasing the acreage of *Sap* coconut per model contributes to an increase in the ratio of *Sap* coconut per bunch.

Table 2: Normal Sap coconut acreage and embryo cultured Sap coconut in Tra Vinh province

Sap coconut acreage	Normal Sap coconut		embryo cultured Sap coconut	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Under 0.5 ha	30	50	2	29
From 0.5 to 1 ha	25	42	4	57
Over 1 ha	5	8.3	1	14
Total	60	100	7	100
T-value	-0.986			
T-difference value	0.328			

Normal Sap Coconut density and embryo cultured Sap coconut density in Tra Vinh in 2018

According to the survey results, normal *Sap* coconut had an average density of 244 trees/ha, with the average distance being 6 m for each tree and 6 m per row. For embryo cultured Sap coconut, the average density was 229 trees/ha, with an average distance of 7 m for each tree and 8 m per row (

Table *3*). This result was in line with the research of (Duong, 2013) in Cau Ke district, reporting that the average density of *Sap* coconut was 235 trees/ha, higher than the recommended average density ranging from 160 to 200 trees/ha (Thuy et al. 2016). The reason may be due to poor soil, and farmers have no intensive investment in coconut. According to Thuy et al. (2016), planting distance depends on the variety, soil fertility, climate conditions, and models of intensive cultivation or intercropping.

Table 3: Normal Sap coconut planting density and embryo cultured Sap coconut planting density in Tra Vinh province.

Targets	**Average**	**Standard deviation**	**Range**
Normal Sap coconut			
Number of tree per ha	244	43	100 - 350
Tree distance (m)	5.8	1.0	4 - 9
Row distance (m)	5.8	1.1	4 -10
Embryo cultured Sap coconut			
Number of tree per ha	229	32	200 - 280
Tree distance (m)	6.9	1.0	6 - 8.5
Row distance (m)	7.7	1.0	6 - 9

The age of exploitation of normal Sap coconut and embryo cultured Sap coconut in Tra vinh

Coconut is a perennial tree. The average life expectancy of coconut is high. The average age of exploitation of Makapuno is 50 years, with the lowest being 20 years, and the highest, 100 years old. The average age of exploitation for embryo cultured Sap coconut has not been determined due to recent planting in 2008 (

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Table ***4***).

According to research by Copeland (1931) and (Ramirez, and Mendoza, 1998), the Sap coconut and normal Sap coconut have been simulated all characteristics except endosperm only.

Table 4: The age of exploitation acreage normal Sap coconut and embryo cultured Sap coconut in Tra Vinh province

The age of exploitation	Average (year)	Standard deviation	Range
Normal Sap coconut			
Normal *Sap* coconut age of exploitation	56	16	20 -100
Embryo cultured *Sap* coconut			
Embryo cultured *Sap* coconut age of exploitation	-	-	-

Origins of coconut variety normal Sap coconut and embryo cultured Sap coconuts in Tra Vinh
The results of

Table ***5*** show that the normal *Sap* coconut, mainly by farmers themselves, accounts for 73%, while other home garden varieties account for 47%. The reason is because the propagation must be fruits picked from *Sap* coconut's bunch, so farmers have to choose from nearby gardens to ensure the crop will have *Sap* coconut. This result is also in line with the research of Thuy et al (2016) reporting that farmers have the habit of cultivating coconut varieties themselves, accounting for 98%. For coconut implanted embryos, farmers buy seeds from the institutes, while the school accounts for 86% of the total occurrence, and two households receive 29% of seed support. The reason is that farmers do not p their own, but the production of embryos with embryo cultured Sap coconut requires investment in equipment and technological processes.

Table 5: Origin of normal Sap coconut and embryo cultured Sap coconut in Tra Vinh province.

Origin	**Normal *Sap* coconut**		**Embryo cultured *Sap* coconut**	
	Frequency	**Percentage (%)**	**Frequency**	**Percentage (%)**
Self-propagation	44	73	0	0
Bought from another garden	28	47	0	0
Bought from the institute	0	0	6	86
Supported	0	0	2	29

Time give fruit for normal Sap coconuts and embryo cultured Sap coconuts
Sap coconut has three types of pollination as coconut: cross-pollinated (Tall coconut), self-pollinated (Low/dwarf coconut), and semi-pollinated (Cross coconut) (*Freemond, et al. 1966, Sukendah, 2018*). Draft *Sap* coconuts have time for early fruit production and a higher level of uniformity in the population (*Mashud, and Manaroinsong, 2007).* According to the results collected from farmer households, the average starting time for fruit production is when Sap coconut is nearly 3.7 years of age and stable when it is nearly 5.6 years of age. Embryo cultured Sap coconuts produces fruits when the trees are 3.5 years old and stable fruits when they are 5.9 years old (
Table ***6***). This result is in line with the assessment of the Department of Crop Production (Department of Crop Production, 2017) reporting that the flowering time for high coconut group is 5 to 7 years, while it takes 3 to 4 years for the short coconut group.

Table 6: Time give fruits of in Tra Vinh province.

Targets	**Average**	**Standard deviation**	**Range**
Normal Sap coconut			
Time give fruits	3.8	0.8	2.5 - 6
Time give stable fruits	5.6	1.4	4 - 12
Embryo cultured Sap coconut			
Time give fruits	3.5	1.0	3 - 5
Time give stable fruits	5.9	1.1	5 - 7

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Productivity of normal Sap coconut and embryo cultured Sap coconut in Tra Vinh province in 2018

According to the survey results, the total number of trees producing *Sap* fruits in the *Sap* coconut garden is only 40 to 75%, while the remaining trees do not produce *Sap* fruits. The reason is that the varieties taken from the

dominant pupil do not produce copra fruits, and the coconuts implanted are propagated from the *Sap* coconut (homozygous recessive) fruits, for the percentage of trees for copra to reach 100%. For ordinary copra, the average of 47 fruits /tree /year of 13 Sap fruits/tree /year reaches 27% (

Table *7*). This result is in line with the study of Ismail et al. (2013) in Indonesia, stating that the *Kelapa kopyor* is of high coconut group, with a very low percentage of copra ranging from 1 to 3 Sap fruits /bunch, or regularly. The amount of copra per bunch varies, and sometimes there is no copra on the stick. For embryo cultured *Sap* coconut, the average fruit is 47 fruits /tree /year including 41 copra /tree /year reaching 87%. This result is also in line with a report of Romulo (2013) stating embryo cultured *Maprao kathi* on Burmese Island, Thailand at 100% copra/bunch.

Table 7: The yield of normal Sap coconut and embryo cultured Sap coconut in Tra Vinh province

Targets	Average	Standar deviation	Range
Normal *Sap* coconut			
Total fruits/ha/year	10,306	3,246	4,000 – 18,000
Total *Sap* fruits/ha/year	2,342	1,026	120 – 5,250
Average fruits/tree/year	47	15	22 - 83
Average *Sap* fruits/tree/year	13	2.9	7.1 - 19
Ratio (%) Sap fruits /tree/year	27		33 - 23
Embryo cultured *Sap* coconut			
Total fruits/ha/year	9,647	2,381	7,680 – 14,400
Total *Sap* fruits/ha/year	9,058	2,065	7,488 – 13,200
Average fruits/tree/year	47	13	36 - 72
Average *Sap* fruits/tree/year	41	13	31 - 69
Ratio (%) *Sap* fruits /tree/year	87		88 - 96

Pests and diseases on normal Sap coconut and embryo cultured Sap coconut in Tra Vinh province

As earlier noted by the authors at the coconut orchards, there was no difference in the harmful objects on *Sap* coconut and embryo cultured *Sap* coconut. The main harmful objects include coconut weevils with 68% on *Sap* coconut and 43% on embryo cultured *Sap* coconut; coconut beet accounted for 48% normal *Sap* coconut and 57% embryo cultured *Sap* coconut. Some common diseases include falling young fruit with 27% of normal *Sap* coconut and 29% of embryo cultured *Sap* coconut, rotten shoots with 15% of normal *Sap* coconut, and 15% of embryo cultured *Sap* coconut and other diseases including leaf spot fire, and leaf blight with a small percentage. As noted by the authors, farmers often use Basudin, Regent, Furadan, or mosquito spray (for young coconuts) to prevent weevils, coconut beetles, and beetles, while some farmers release parasitic bees to treat beetles (

Table ***8***).

Table 8: Pests and diseases in normal Sap coconut and embryo cultured Sap coconut in Trà Vinh province

Pests and diseases	Normal *Sap* coconut		Embryo cultured *Sap* coconut	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Weevil	41	68	3	43
Ladybugs	29	48	4	57
Beetles	10	17	2	29
Mouse	8	13	0	0
Bugs	1	1.7	0	0
Falling young fruits	16	27	2	29
Stinky	9	15	1	14

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Leaf spot fire	6	10	0	0
Burned leaf	2	3.3	0	0

Consumption of normal Sap coconut and embryo cultured Sap coconut in Tra Vinh province

Table ***9*** shows the results for consumption of normal *Sap* coconut and embryo cultured *Sap* coconut. For Sap fruits, farmers often bring products to the market for sale, accounting for 59%, followed by garden sales, accounting for 41% and without a contract to cover the product. The reason is that the number of normal *Sap* coconut per collection is not much and unstable, so farmers often choose to bring to the market and sell at collection points. Private households with large areas may have traders to buy in the garden. For embryo cultured

Sap coconut, 62% is sold in the garden, with 2 households (accounting for 25%) sold in the market and 1 household (accounting for 13%) sold to the company. The reason is that the number of harvests per time is large and stable, resulting in coconut farmers having formal or informal contracts with coconut buyers in the garden.

Table 9 The forms of consumption of normal Sap coconut and embryo cultured Sap coconut in Tra Vinh province.

Forms of consumption	**Normal *Sap* coconut**		**Embryo cultured *Sap* coconut**	
	Frequency	**Percentage (%)**	**Frequency**	**Percentage (%)**
Garden	32	41	5	62
Market	46	59	2	25
Offtake Contract	0	0	1	13
Total	78	100	7	100

Selling price of normal Sap coconut and embryo cultured Sap coconut in Tra Vinh province in 2018

Results of the research shows that there is no difference in the selling price between *Sap* fruits of normal *Sap* coconut and embryo cultured *Sap* coconut and that the price ranges from 60,000 to 130,000 VND /fruit. This price depends on the quality of coconut copra. According to Adriano and Manahan (1931), based on the level of endosperm filling, *Sap* coconut is classified into 3 types namely type A, B, and C. The best quality being Type C and with the highest price (Figure 2). The quality of copra depends on several factors including variety, harvest time, crop, and farming techniques, etc. The results obtained during the survey shows that type C of the *Sap* fruits accounts for 30 to 50%.

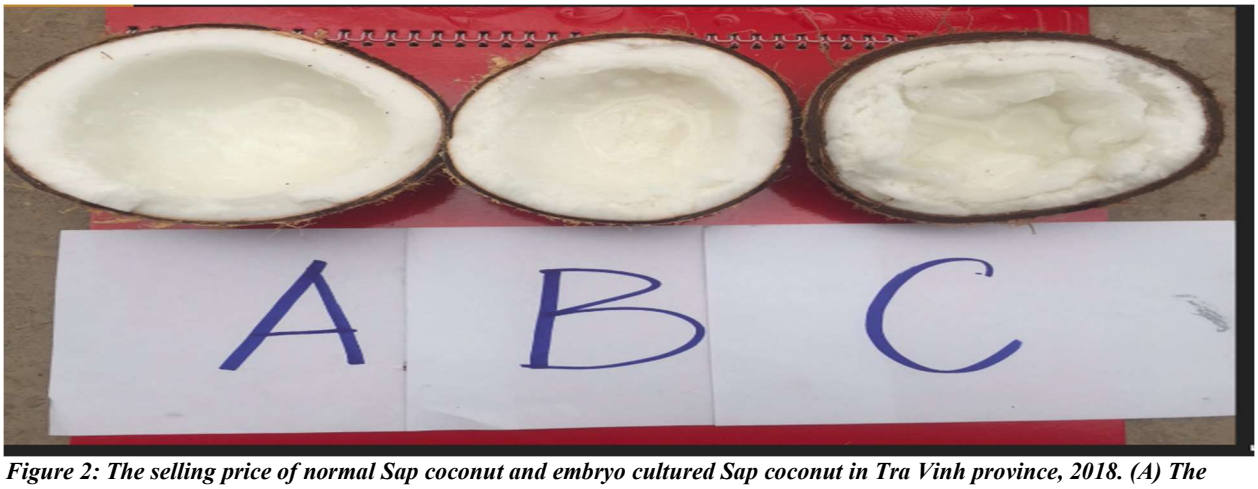

Figure 2: The selling price of normal Sap coconut and embryo cultured Sap coconut in Tra Vinh province, 2018. (A) The endosperm is slightly thicker and softer than coconut; B) The endosperm contains about 50% of the fruit's empty space and C) The endosperm almost occupies the empty space of the fruit, with little or no water).

Assessing the economic efficiency of *Sap* coconut model

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Costs and basic cost structure of normal Sap coconut and embryo cultured Sap coconut implants fruit in Tra Vinh province

Table ***10*** shows the results of the cost survey, with the average total cost being 141 million VND/ha per 5 years. Normal *Sap* coconut is often significantly different when compared with embryo cultured *Sap* coconut being 352 million/ha per 5 years. The difference is mainly in the cost of seeds and fertilizer. The reason is that the price of embryo cultured *Sap* coconut is very high, with 0.8 million VND per tree causing farmers to invest more in fertilizers than planting normal Sap coconut. During the basic construction phase of the coconut garden, family labor accounted for the highest proportion, accounting for 20 to 50% of the cost items, and this cost did not differ between the two models. The total basic depreciation cost determined for the common normal *Sap* coconut is 2.9 million VND/ha/year, while that of the embryo cultured *Sap* coconuts is 13 million VND/ha/year for 20 years of business exploitation.

Table 10: Costs and basic cost structure of normal Sap coconuts and embryo cultured Sap coconuts give fruits in Tra Vinh province.

Targets	Normal *Sap* coconut		Embryo cultured *Sap* coconut		Signifficant
	Total 5 years	Average depreciation per year	Total 5 years	Average depreciation per year	
Cost of supplies	58	2.9	263	13	**
Ditch litchi	39	2.0	38	1.9	ns
Type of *Sap* coconut	4.1	0.18	182	9.1	**
Fertilizer	12	0.57	38	1.9	**
pesticides	0.95	0.05	1.6	81	ns
machines	1.2	0.06	0.49	0.02	ns
Gasoline	0.53	0.03	1.0	0.05	ns
Other costs	0.92	0.05	1.5	0.08	ns
Labor costs	83	4.1	89	4.5	ns
Hire labor	12	0.6	17	0.85	ns
Family labor	71	3.5	72	3.6	ns
Total cost	70	3.5	280	14	**
Total cost (include family cost)	141	7.0	352	18	**

*Note: ns (no difference), * and ** difference at 5% and 1% through T-test (Unit: milion).*

Analysis of the economic efficiency of normal Sap coconut and embryo cultured Sap coconut in Tra Vinh province

Table ***11*** shows that the two production models are highly profitable for farmers. Total spending of embryo cultured *Sap* coconut (27 million/ha/year) is higher than normal *Sap* coconut (13 million/ha/year) being 14 million VND. The profit of embryo cultured *Sap* coconut is extremely high (907 million VND/ha/year), higher than that of normal *Sap* coconut (220 million VND/ha/year) of about 687 million VND/ha. The average efficiency of embryo cultured *Sap* coconut is 21 times more and statistically different from the average capital efficiency of coconut being 8.8 times. The results showed that this is a plan adapted to drought and salinity conditions, which brought a very high economic efficiency, suitable for the conversion of inefficient rice-growing areas to coconut plantation and building large material areas for processing and export.

Table 11: Costs, income, economic efficiency of normal Sap coconut and embryo cultured Sap coconut in Tra Vinh province

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Target	Normal *Sap* coconut	Embryo cultured *Sap* coconut	Significant
Cost of supplies (1)	9.6	21	**
Fertilizer	5.6	7.1	**
Pesticides	0.24	0.32	ns
Machines	0.42	0.36	ns
Gasoline	0.22	0.22	ns
Other costs	0.22	0.30	ns
Depreciation of supplies	2.9	13	**
Labor			
Labor costs (2) = [(a)+(b)+(c)]	20	23	ns
Employment (a)	2.7	4.4	ns
Family labor (b)	13	14	ns
Labor depreciation (c)	4.2	4.5	ns
Depreciation of hired labor (d)	0.62	0.85	ns
Depreciation of family labor	3.5	3.6	ns
Total cost [(1)+(a)+(d)]	13	27	**
Total cost (with family labor) [(1)+(2)]	30	45	**
Total revenue	250	952	**
Total workday family labor (day)	111	120	ns
workday family labor (day)	88	96	ns
Depreciation workday family labor (day)	24	24	ns
Profit	237	925	**
Capital efficiency	20	35	**
Profit (with family labor)	220	907	**
Capital efficiency (with family labor)	8.8	21	**

*Notes: ns (no diference), * and ** different at 5% and 1% using T-test (Unit:million/ha/year).*

Factors affecting profit of normal Sap coconut and embryo cultured Sap coconut models in Tra Vinh province, 2018.

This study used multivariate linear regression model with Stepwise method, which is the method of putting meaningful variables into the model until to get the best model (Trong, and Ngoc, 2008). In this study, the profitability of normal *Sap* coconut and embryo cultured *Sap* coconut models had been researched basically on 10 independent variables. The normal *Sap* coconut model was recognized 2 factors affecting profitability; the embryo cultured *Sap* coconut model had only one factor affecting the profitability of model in Tra Vinh province.

- **Normal *Sap* coconut model:**

Table *12* showed that the correlation coefficient (r) = 83,3%, means the profit of normal *Sap* coconuts was closely related to the number of mutant fruits / ha / year and selling price. In addition, determination coefficient (R^2) = 91,3% to affirmative the profit of model was affected by the factors of mutant fruit /ha/year and selling price; 8,7% other factors was influenced and not included in the model. The VIF coefficient of all independent variables used less than 2, suggesting that the variables included in the model were not collinear.

The number of mutant fruits/ha/year factor had a standardized regression coefficient = 0.405, which showed that the profit of normal *Sap* coconut model was proportional to the total number of mutant fruits/ha/year.

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The analysis results showed that the selling price had a standardized regression coefficient of 0.655, showing the correlation between the selling price and the profit of normal *Sap* coconut models. In other words, when the selling price was higher, profits of models also increased.

Table 12: Results of the regression model of normal SAP coconut model profit in Tra Vinh province, 2018

Affecting factors	Unit	Standardized regression coefficient	Significant Level	VIF coefficient
Constant		377,004.7	0.00	
Academic level	Class	0.020	0.759	1,278
Experience	Year	0.118	0.052	1,081
Acreage	Ha	-0.020	0.752	1,188
Density	Tree	0.066	0.353	1,515
Coconut age	Year	0.207	0.003	1,335
Average sap fruit/tree	Fruit	-0.033	0.616	1,293
Total mutant fruits/ha/year	Fruit	0.405	0.00	1,258
Selling price	1000 VND	0.655	0.00	1,874
Correlation coefficient r		83,3		
Determination coefficient R^2		91,3		
Significant level		0,00		

- **Embryo cultured *Sap* coconut model**

Table ***13*** cited that value of the correlation coefficience r = 95.5%, ditermination coefficience R^2 = 91.1%, and significant level = 1%. The profit of embryo cultured *Sap* coconut model was strong affected by total mutant fruits/ha/year factor with 91.1% and other fators were 8.9%.

Table 13: Results of the regression model of embryo cultured SAP coconut model profit in Tra Vinh province, 2018

Affecting factors	Unit	Standardized regression coefficient	Significant Level	VIF coefficient
Constant		1,904,652.8	0.048	
Experience	Year	-0.468	0.558	3,568
Coconut age	Year	0.447	0.032	5,210
Acreage	Ha	-0.973	0.504	10,928
Total mutant fruits/ha/year	Fruit	0.893	0.000	1,995
Density	Tree	0.376	0.016	3,789
Correlation coefficient r		95,5		
Determination coefficient R^2		91,1		
Significant level		0,038		

Factors affecting the proportion of Sap fruit and the quality of copra of normal *Sap* coconut and embryo cultured *Sap* coconut give fruit in Tra Vinh province

Factors affecting the proportion of Sap fruit and quality of copra normal Sap coconut and embryo cultured Sap coconut give fruit in Tra Vinh province

According to the survey, factors affecting the rate of mutant fruit of *Sap* coconut include the dry season of 63 households (accounting for 94%), embryo cultured *Sap* coconut of 56 households (accounting for 84%), organic fertilizer of 52 households (accounting for 78%), specialized farming of 49 households (accounting for 73%), the density of 37 households (accounting for 55%) of sandy soil, farming techniques of 36 households (accounting for 54%) and other factors including acid sulphate soil, saline soil, alluvial soil, intercropping, mud-

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ploughing, irrigation water, chemical fertilizers, pests, education, and experience, while the rainy season accounts for less than 50%. On the group of embryo cultured *Sap* coconuts, the influencing factor is seed and specialized cultivation, accounting for 100%, followed by the dry season with 43% (

Table ***14***).

Table 14 Factors affecting normal Sap coconut ratio and embryo cultured Sap coconut in Tra Vinh province.

Targets	Normal *Sap* coconut		Embryo cultured *Sap* coconut	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Sap coconut variety (embryo transplantation)	49	82	7	100
Alkaline soil	3	5.0	0	0
Saline soil	2	3.3	0	0
Sand	32	53	0	0
Slob	10	17	0	0
Specialized farming	42	70	7	100
Intercropping	10	17	0	0
Density	37	62	0	0
Mud	12	20	0	0
Irrigation water	6	10	0	0
Cultivation techniques	29	48	1	14
Chemical fertilizers	19	32	2	28
Organic fertilizer	45	75	2	28
Rabid epidemic	14	23	0	0
Academic level	3	5.0	0	0
Experience	15	25	0	0
Dry season	56	93	3	43
Rainy season	1	1.7	0	0

Source: The survey data of the author, 2019.

The farmer's identity is in line with the research report of Harris (1990) because the *Sap* fruit is genetic. *Sap* coconut's characterictics is promoted by recessive gene Sap, that is, 50% of female parents and 50% of male parents. There is a formation of *Sap* coconut if there is an interference between the pollen and pistil, with each having properties of *Sap* coconut (Tahardi, 1997). Particularly, seasonal factors suggest that the dry season affects the rate of *Sap* fruit per bunch. The reason may be because the dry season facilitates the crossing between pollen and pistil more than the rainy season.

Factors affecting the quality of normal Sap coconut and embryo cultured Sap coconut give fruit in Tra Vinh province

According to the farmers surveyed, the quality of *Sap* coconut fruit is mainly influenced by factors in the dry season of 55 households (accounting for 82%), organic fertilizer of 46 households (accounting for 69%), chemistry fertilizer of 44 households (accounting for 66%), and *Sap* coconut varieties of 34 households (accounting for 51%). For embryo cultured *Sap* coconut, the farmers also reported that regarding the quality of *Sap* coconut, the quality of seedlings, dry season, organic fertilizer, and the time of harvest range from 71 to 100% (

Table ***15***).

Table 15: Factors affecting the quality of normal Sap ratio and embryo cultured Sap fruit in Tra Vinh province

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Targets	Normal *Sap* coconut		Embryo cultured *Sap* coconut	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Embryo cultured *Sap* coconut variety	15	25	2	29
Normal *Sap* coconut variety	34	57	5	71
Alkaline soil	2	3.3	0	0
Saline soil	2	3.3	0	0
Sand	31	52	0	0
Slob	14	23	0	0
Specialized farming	19	32	5	71
Intercropping	6	10	0	0
Density	11	18	0	0
Mud (cover the coconut bank with mud)	13	22	0	0
Irrigation water	6	10	0	0
Chemical fertilizers	37	62	2	29
Organic fertilizer	39	65	7	100
Rabid epidemic	9	15	0	0
Academic level	6	10	0	0
Experience	17	28	0	0
Dry season	48	80	7	100

The results of this research are in line with the research of Anh et al. [**Error! Reference source not found.**] reporting that *Sap* coconut cannot be distinguished from coconuts on the basis of the physical characteristics of their fruits. The only possible way of distinguishing between *Sap* coconut and other coconut is to shake the coconut when ripe (≥ 11 months of age).

Therefore, it is impossible to distinguish and identify *Sap* fruit when it is still young (unripe, <11 months old). Therefore, choosing the time of harvest greatly affects the quality endosperm of *Sap* fruit. Therefore, the crystallinity of endosperm of *Sap* fruit is 9.6%, lower than coconut of 23%, hence the kernel of *Sap* fruit becomes very soft. The formation of galactomannan, and the thickness of kernel of *Sap* fruit can be influenced by several factors including genetics, climate, and farming techniques.

4. CONCLUSIONS

Conclusions drawn from the study carried out include the following:
1) There is no difference between normal *Sap* coconut and embryo cultured *Sap* coconut; the average time for fruit production of *Sap* coconut is about 3.6 years, while the age for stable fruit ranges from 5.6 to 5.9 years after planting with an average yield of 47 fruits per tree yearly.
2) Investment cost for embryo cultured *Sap* coconut planting model is 2.5 times higher than normal *Sap* coconut, focusing on initial seed purchase with an average total cost of 352 million VND/ha/5 years, while the average profit is about 925 million VND/ha/year, which is 3.9 times higher than the average *Sap* coconut.
3) There are several factors affecting profit: the profit of normal *Sap* coconuts was closely related to the number of mutant fruits /ha/year and selling price and the profit embryo cultured *Sap* coconut model was strong affected by total mutant fruits/ha/year factor.
4) There are several factors affecting the rate of *Sap* fruits per bunch including the dry season, and specialized cultivation, but the species is an important factor that determines the properties of *Sap* fruit, accounting for *Sap* fruit ratio of 97% in planting embryo cultured *Sap* coconut seedlings, and with specialized cultivation, the *Sap* fruit ratio for normal *Sap* coconut is 27%. *Sap* fruit is only expressed when the fruit is 11 months old. Some factors that determine the quality of *Sap* coconut, include the dry season, varieties, organic fertilizer, and early, or late harvesting, all affecting the quality and thickness of *Sap* coconut.

5. RECOMMENDATIONS

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Recommendations drawn from the study carried out include the following:
1) There should be continuous researches on the effects of the crop, seed quality, fertilizer, harvesting time, intensive planting on the rate, and quality of *Sap* coconut.
2) *Sap* coconut farmers should focus on planting a large area to increase the percentage of *Sap* fruits.
3) Embryo cultured *Sap* coconut is a plant species that brings very high profit and has adaptability on acid soil, salinity, and drought. Therefore, this type of crop is suitable for the conversion of inefficient rice land.
4) Products and by-products from *Sap* coconut are very diversified and useful, and thus experiences of farmers and scientific studies will help to promote trade, enhance value and expand production areas.

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Conflicts of interest
The authors declared that they have no conflicts of interest.

REFERENCES

[1] Abraham, A., C.A. Ninan, and P. Gopinath, (1965**)** "Cytology of development of abnormal endosperm in Philippine macapuno coconuts", Cytologia, 18: 395-402.
[2] Adriano, F. T., and M. Manahan, (1931), "The nutritive value of green, ripe and sport coconut (buko, niyog, and macapuno)". Philippine Agriculturist, 20(3):195-198.
[3] Angela S. A and E.M.T. Mendoza, (1993), "Respiratory Activity of the Normal and Makapuno Coconut Endosperms". Phillip.J. Crop Sci, 1993, 18(3):1995-199.
[4] Anh, T.Q., L.T. Minh., T.T.T. Anh., and T.V.Hai, (2012), "Invitro propagating of Sap coconut (makapuno coconut)". Journal of Agriculture and rural Development, 20:12-18.
[5] Balasubramanian, K., R.D. Sothary, and A.A. Hoover, (1976), "Polysaccharide of the kernel of maturing and matured coconut". Journ. Food Sci., 41:1370-73
[6] Cedo, M.L.O., E.V. de Guzman, and T.J. Rimando, (1984), "Controlled pollination of embryo-culture "Makapuno" coconut". Philipp. Agric, 67:100–104.
[7] Copeland, E.B. (1931), "The Coconut Macmillian and Company", Ltd.: Basingstoke, UK
[8] Cruz, S. S. and D. A. Ramirez, (1966). "The cytology of the developing endosperm of the normal and mutant (Macapuno) coconut". Phil. Agriculturist., 52(2):72-81
[9] Cuong, L.D. (2018), Evaluating the financial efficency of Sap coconut and normal coconut. Master thesis. Tra Vinh University, pp: 37-39.
[10] De Guzman, E.V., and D.A. Del Rosario, (1964), "The growth and development of Cocos nucifera L. 'Makapuno' embryo in vitro". Philipp. Agric. 48: 82–94.
[11] De Guzman, E.V., and G.C. Manuel, (1977), "Improved root growth in embryo and seedlings culture of coconut 'Makapuno' by the incorporation of charcoal in the growth medium". PJCS: 11: 35–39.
[12] Department of Agriculture and Rural Development of Tra Vinh, (2018), "Action plan for upgrading the coconut value chain of Tra Vinh province, period 2018-2020", pp:17-22.
[13] Department of Crop Production. Technology of coconut seed multiplication and production, Posted: June 28, 2017. http://www.cuctrongtrot.gov.vn/TinTuc/Index/3674
[14] Duong, N.T.K. (2013**),** Report on the results of the implementation of the Mission "Exploiting and developing coconut genetic resources". Coconut seed production development project for the period of 2011-2015. Ministry of Industry and Trade, Government of Vietnam, pp: 65-70.
[15] Freemond, Y., R. Ziller., and N. D. Lamothe, (1966) "The coconut palm". International Potash Institute. Berne/Switzerland**.**
[16] Harries, H.C. (1990), "Malesian Origin for a Domestic Cocos nucifera L. Di dalam: Baas P, Kalkman K, Geesink R, editor. The Plant Diversity of Malesia. Dordrecht: Kluwer Academic, pp: 351-357.
[17] Hong, N. T. C. (2017), "Analysis of technical efficiency of rice farming households in a large sample field model in Hau Giang province". Master thesis, Can Tho university. pp: 40-45.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

[18] Islam, M. N., A. K. Azad, L.O. Namuco, T.H. Borromeo, M.L.O. Cedo, and E.A. Aguilar, (2013), "Morphometric Characterization and Diversity Analysis of A Makapuno Coconut Population In U.P. Los Banos". Pakistan J. Agric. Res. Vol. 26 No. 4.
[19] Ismail, M., H. Novarianto, Sukendah, D. Sukma and Sudarsono, (2013), "Productivity of Three Dwarf Kopyor Coconut Varieties from Pati, Central Java, Indonesia". Pages 19-28. CORD, International Journal on Coconut R&D – Vol.29 No. 2.
[20] Kiet, N. T. (2017), "Analyze the efficiency of program's The rice production activities with farmers in the field and enterprises in Vinh Hung District, Long An Province. Journal of science Can Tho university. pp: 45-51.
[21] Long, V.V. (2007), "Research applied techniques to seeding, conservation and building the extensive Sap coconut coconut model in Cau Ke district, Tra Vinh province". Ministry of Industry and Trade, Government of Vietnam, pp:43-47.
[22] Mashud, N., and E. Manaroinsong, (2007). "Embryo culture technology for kopyor coconut development". Buletin Palma. 33: 37-44.
[23] Ngoc, N. T. H. (2015), "Analyze the efficiency of maize production of households in Vinh Long province". Master thesis, Can Tho university. pp: 37- 42.
[24] Ramirez, D.A., and E.M.T. Mendoza, (1998), "The Makapuno Coconut" The National Academy of Science and Technology: Manila, Philippines, p65.
[25] Romulo, Jr., N. (2013), Prospects of Value-Added Coconut Products in the Domestic and Export Market. The APCC-DOA International Training on the Processing of Value-Added Coconut Products, Bangkok, Thailand.
[26] Sukendah, Z.A., W. Sri, and W. W. Bakti, (2018) "Morphological Characters of Kopyor Coconut Grown In Sumenep, Madura, Indonesia". ISNAR C2FS Proceeding Natural Resources Climate Change and Food Security in Developing Countries Surabaya, Indonesia, June 27-28, 2011. Biodiversity and Conservation, oral Presentation. pp: 245-255.
[27] Tahardi, J.S. (1997), "Kelapa Kopyor Sebagai Komoditi Alternatif Agribisnis". Bogor: Warta Puslit Biotek Perkebunan. Bogor, pp: 16-21.
[28] Thuy, N.T. (2008), "Survey, evaluation and research the ways to improve the Sap coconut fruit coconut ratio for Sap coconut of Vietnam". Ministry of Industry and Trade, Government of Vietnam, pp: 52-59.
[29] Thuy, P. T. P., Linh, L. T., Hau, Đ. V. and N. N. Trai, (2016) Final report "propagating Sap coconut by empryo cultured method in Tra vinh province". Tra Vinh University, Vietnam. pp: 25-30.
[30] Torres, J. P. (1937), "Some notes on Makapuno coconut and its inheritance". Phill. Journ. Agri. 8, 27-29.
[31] Trong, H. and C. N. M. Ngoc, (2008) "Used SPSS software for quantitative research". Ho Chi Minh Economics University. pp: 57-65.
[32] Zuniga, L. C. (1953), "The probable Inheritance of the Makapuno Character of Coconut". Philip. Agric. 36: 402-409.