# An Economic Analysis between GM and Non-GM Maize Production in Southern Vietnam

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## Abstract

This paper aims to compare the economics of GM maize and non-GM maize production across agro-ecological zones in Southern region. Data was collected through a two-stage randomly stratified sampling procedure. A total of 296 maize growers was surveyed by face-to face interviews using a well-structured questionnaire. The method of univariate analysis was applied. Results showed that costs of GM maize production were significantly lower than ones of non-GM maize per hectare. Of which, GM maize seed costs reflected obviously the difference based on the large deviation in price. In other words, herbicide use was still highly maintained for both maize types in Dak Lak and Dong Nai provinces. Total revenue, net profit and profit-cost ratio of GM maize cultivation contributed higher profitability compared to those of non-GM maize. Though initial outcomes presented relative benefits of GM maize variety utilization in the study areas. There is still an essential consideration for more comparative studies in order to assess the impact of new varieties more comprehensively.

Keywords: Genetically modified maize, Cost, Profit, Southern Vietnam

JEL classification: Q16, Q18, Q55

## Introduction

The adoption of transgenic crops (maize, soybean, cotton, canola, etc.,) continued to grow for the 19th consecutive year of global commercialization since 1996 (James, 2015). There are evidences indicated that genetically modified (GM) crops contributed significantly to reduce chemical use by 37%, to increased yield in range of 6% - 30% and profitability was increased by 68% on average. These results are higher in developing nations than industrial ones (Klumper & Qaim, 2014). In contrast, other studies remained a contrary viewpoint of economic performance. Even though obvious benefits of GM crops are the increase in yield and labor cost reduction, these however depend on social-economic, geographical characteristics and institutional systems (Raney, 2006; Smale et al., 2009; Mutuc et al., 2011; Kleerebezem & Raney, 2006).

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In Vietnam, maize is one of the major staple food crops as well as a main source of income to many poor-resource farmers, households in mountainous, highland and high slope regions. Since the 1986s, when agricultural innovations and policy reforms had been introduced. Maize cultivation systems in particular had been highlighted by releasing hybrid maize varieties aimed at improving farm income, economic efficiency since the early 1990s. Its adoption by smallholders, poor-resource and low-income farmers had rapidly risen for two decades afterward due to positive supports of the government. After 25 years later, genetically modified maize varieties were proposed and officially approved for commercial production by the Department of Agricultural and Rural Development in March 2015 on the base of series of agricultural biotechnological policies to be issued (Decision 95/2007/QD-BNN; Decree 69/2010/ND-CP; Circular 29/2014/TT-BNNPTNT; Circular 06/2015/TT-BNNPTNT). This strategic step is supposed to meet three targets in short-run and long-run including (i) providing sources of high-yield maize seed, (ii) improving farmer's profitability and lowering production costs, and (iii) reducing the imported maize grain quantity. One of the important roles of introducing GM maize varieties is that the ability of herbicide tolerance and pesticide resistance. This kind of maize variety is expected to contribute the improvement of yield, solving for weed pressure and pest infestation in crucial zones of maize cultivation covering Northern upland, Central highlands upland and Southeast. Field trials have been conducted in the whole country since 2010 to assess comparatively agronomical characteristics, geographical adaptation, economic benefits between GM and non-GM maize varieties. However, these trials were done mainly for governmental purposes without any survey work to be done to compare cost and profit of these both type of maize varieties in household scale. This paper presents a comparative assessment of cost and profit aspects between GM and non-GM maize production in small-scale farmers in Southern Vietnam.

## Methodology

### Area Description

Southern region where covers three zones (i) the central highland, (ii) the Southeast and (iii) the Mekong river delta has a total of 11,9 million hectares, of which agricultural land area is nearly six million hectares (General Statistics Office of Vietnam, 2015). Topography is relative flat and the slope decreases in range from medium to low along the Central highland to the Mekong River zone. Total population is approximate 39,32 million people (General Statistics Office of Vietnam, 2015). The zones have high mechanization in agriculture practices and tend to purposively commercial production. The output of maize grains is accounted for approximately 45% while maize areas are accounted for 38% compared to the nationwide. In addition, livestock industry develops rapidly in Southern regions in recent years, thus the demand of raw materials to response animal feeds is increasing. Mostly, farmers are categorized as small-scale, poor-resources and low-income households. Maize cropping patterns are diversity in combination with other crops such as rice, bean, cassava, cotton, tobacco, fruit trees, industrial plants. Particularly, the major patterns in the central highland and

Southeast zones are maize monoculture, maize-beans, maize-cotton while maize-rice is based farming systems in the Mekong river delta. Maize cropping calendar differs across agro-ecological zones characterizing various geographical, irrigation, climate conditions. In central highland and Southeast, farmers grow two maize crops in Summer-Autumn (April-August) and Autumn-Winter (July-November) under monoculture and intercropping modes. In contrast, in the Mekong river delta, farmers mainly grow one maize crop in Spring-Summer (November-February). All maize in these agro-ecological zones is cultivated on rain-fed and non-irrigated areas except for the Mekong river delta.

**Source of Data**

This study was based on cross-sectional data from primary sources through the use of structured and pre-tested questionnaires to collect factors of maize production in consist of input, labor costs, service fees and the production output. The survey was organized during October in 2016 for collecting data of wet and dry seasons of crop years 2015-2016.

**Sampling Procedure**

A two-stage randomly stratified sampling procedure was applied. In the first stage, three high GM maize-adopting provinces from each agro-ecological zone under the Southern in consist of Dak Lak, Dong Nai and An Giang are chosen based on the density of GM maize adopters, conducted field trials and the dominance of maize production systems. The second stage involved random selection of respondents from six purposively assigned districts in each province following the instruction of local authorities. A total of 296 targeted maize farmers were selected for face-to-face interview. Of which respondents were classified into 222 Non-GM maize and 74 GM maize famers respectively.

**Data Analysis Techniques**

The obtained data from the survey were subjected to univariate analysis using Stata 12 and Excel 2016 applications. Costs and profit analysis of GM and non-GM maize production was

measured by the profit-cost ratio. The details are expressed as below:

- Profit ($\pi$)= Total revenue (TR)–Total cost (TC)
- Total revenue (TR) = Output price ($P_i$)*Output quantity ($Q_i$)
- Total cost (TC) = Total variable cost (TVC) + Total fixed cost (TFC)
- Total variable cost (TVC) = Price of inputs ($P_j$)*Purchased quantity of inputs ($X_j$)
- Total fixed cost (TFC) = Depreciation (D) + Other non-cash costs
- Profit-cost ratio = Profit ($\pi$)/Total cost (TC)

Input costs in the survey covered payments for input factors such as seeds, fertilizers, herbicides, pesticides labor, service fees, machines and other expenses involved from land preparation to post harvest. The labor cost contains labor service fees for man-day, man-machine day during the stages of field cleaning, land preparation and cultivation practices (ploughing, harrowing, pricking holes in the ground or making drains), chemical application (fertilization and spraying of pesticide and herbicide) and pre-and post-harvesting practices (seed planting, weeding, irrigating, harvesting, hauling and husking). The production service fees for man-day include both hired labor and family labor members. The corresponding wage per farming practice was calculated by multiplying number of laborers to number of days per labor to operation time per day to the prevailing service or hired price given per laborer per day. Production output is the total quantity in kg multiplied by the prevailing price of maize grain per kilogram in cropping year 2015-2016. Depreciation covered costs of wear and tear of machines, equipment and tools. The straight-line method is used in computing for depreciation. The life span of above items was also consulted by the circular 45/2013/TT-BTC of Vietnam Ministry of Finance for agricultural machines, equipment.

## Results and Discussion

### Agricultural Land Allocation to Maize Production

The obtained data revealed that households utilized their owned or rental agricultural land for production activities in medium and large-scales at 1.65±0.77 hectares on average in three provinces. However, land utilization for maize cultivation was commonly small and medium-scales in range of 0.80±0.35 hectares. The land allocation to cultivated GM and non-GM maize areas was also significantly different.

Table 1 indicated that mean GM maize area was significantly smaller than mean of non-GM maize areas 0.69±0.32 hectares compared to 0.84±0.35 hectares respectively. Land allocation to growing maize in An Giang province was relatively confined with a mean of 0.43±0.19 and 0.49±0.21 hectares between both maize types. Most of the agricultural land areas in this zone were employed for other crucial crops and trees as such rice, fruit trees or aquaculture. In contrast, cultivated maize land areas were medium and large in Dak Lak and Dong Nai provinces. The difference of land utilization for GM and non-GM maize varieties were statistically significant in Dak Lak province, but not in Dong Nai province. Otherwise, land fragmentation was primarily one or two land plots (50.68%, 34.80% respectively) on average while the average planted maize land area per plot was 0.49±0.23 hectare(s) small. Land tenure of agricultural land was mainly acquired by land-right property or inheritance accounting for 97.72%. A small proportion was 2.28% found of rent agricultural land with a fixed or agreed land fee. In other words, the land allocation for multi-crops, plants such as coffee, fruit trees, cashew nut, rice, cassava, etc., were as a result of this fragmentation of farm land. The explanation was also evidenced by average planted maize area per plot in range of 0.58±0.22, 0.64±0.20 and 0.47±0.19 hectare in three provinces respectively. To sum up, it is

popular to identify small-scale farmers with a restricted land area for maize cultivation and agricultural production in provinces in Southern.

**GM and Non-GM Maize: Production Costs**

Findings on the costs of maize production were reflected in comparison with both maize types in terms of total variable cost, total fixed cost and total cost. Of which, seed costs, fertilizer, labor wage and production service costs are fundamental input factors. Table 2 demonstrated that the investment in GM maize production per hectare was in range of 14,161.28±3,552.24 thousand dong significantly lower than that of non-GM maize varieties (15,473.18±2,987.44 thousand dong). It is obvious that the major contribution to total cost was obtained from the total variable cost. However, in comparison between maize types total variable cost was statistically significant indifferent. Results were consistent with 13,055.48±3,145.64 and 13,420.01±3125.12 for GM and non-GM maize varieties respectively. The difference of total cost implied the unbalance mainly from seed price and labor costs. Even though the seed price of GM maize on the market was approximately double higher than non-GM maize seeds (see table 4). On the other hand, GM maize varieties have technological advantages of herbicide tolerance and pesticide resistance. This dominance contributed to reduce considerably the demand of chemical use and labor cost in comparison with non-GM maize varieties.

The classification of total cost for GM and non-GM maize by province was showed in table 3. Though the cultivated maize area in An Giang province was lower than that of other provinces, average total cost of maize production per hectare was 17,406.12±3,497.88 some higher than compared to 14,640.21±3,099.34 and 15,740.63±2,884.03 respectively. In explaining the high variation of total cost in this zone is offered by the use of labor costs and service fees, particularly irrigation fees in favorable sites and charges of herbicide, pesticide spraying. In other words, total cost in Dong Nai province was significantly higher than that in Dak Lak province. The increase in fertilizer input such as DAP fertilizer, “Dau Trau” fertilizer had explained for the difference between both provinces as a consequence.

Table 4 below provided costs of input factors in details of two types of maize varieties. Results demonstrated that the investment in production of maize growers concentrated mostly upon seed costs, fertilizers, charges for seed planting and harvesting. Of which, fertilizer costs were the largest paid a mean of 6,618.96±2,608.42 thousand dong. The difference in fertilizer cost of GM maize compared to non-GM maize was statistically insignificant. The deviation of seed price and cost between GM and non-GM maize seeds was the largest found in this survey. For average GM maize seed price was 191.82±4.82 thousand dong and this price was similar to all region of maize cultivation in Southern. In contrast, for average non-GM maize seed price was 111.46±3.62 thousand dong. At the period of survey, only GM maize seeds with one stacked trait of herbicide tolerance and pesticide resistance was available on the market provided by two main seed firms (Dekalb and Syngenta). Seed costs of all the GM maize types were 3,233.92±1,180.27 thousand dong at the mean value more than 80% higher estimated

than non-GM maize types (corresponding 1,899.402±628.31 thousand dong). This cost plays an important role in contributing high level of total cost for GM maize production.

The labor costs were the third important factor to increase total cost of maize production beside seed cost and fertilizer. Among labor cost variables, charges of seed planting and harvesting were the highest paid in range of 1,272.93±564.98 and 2,263.99±711.89 thousand dong respectively. In other words, labor wage of seed planting for non-GM maize was lower than the one of GM maize 1,235.75±512.25 correspondingly compared to 1,384.45±691.90 thousand dong while the payment for harvesting was against 2,392.72±539.44 thousand dong compared to 1,877.80±982.59 thousand dong in both types of maize. The above results also implied that the mechanization level at these practices was low in all zones except for districts Xuan Loc and Cam My in Dong Nai province. It is consistent with the fact that most of the small-scale farmers handled with simple equipment and tools for their maize cultivation without high investment in valuable machines. On the other hand, the mechanization was taken place in majority of the land preparation stages from ploughing to making lines, holes. As a consequence, service costs of these stages remarkably contributed to the total cost of maize production. For all maize varieties, service costs were 1,399.59±783.65 thousand dong covered fees of pre-and post-harvest such as rent land, land preparation, husking, transportation, fuel, lube, electricity, irrigation. The analysis of service costs for non-GM maize was higher than for GM maize corresponded to 1,437.69±779.02 and 1,286.84±791.76 thousand dong. However, the difference across both maize types was statistically insignificant.

Reduction in weeding and pesticide spraying costs which also showed in table 4 closely associated to technological advantage of GM maize varieties. As indicated that maize growers who used GM maize seeds for cultivating in wet and dry cropping seasons in all zones did not pay for these costs. This is explained by two major reasons corresponding to the fact that due to (1) maize growers gained information and knowledge of GM maize benefits of its tolerance and resistance through the local workshops usually organized by seed firms. They decided to use GM maize seeds with the high expectation of self-produced pesticide and once herbicide spraying contained in GM maize seed technology. (2) The second reason is that the prevailing wage of hired labor was high in the zones and a desire of reducing production cost was deliberated. In contrast, for non-GM maize, weeding and pesticide spraying costs were paid in An Giang province where was considerably affected by the insect infestation and weed pressure. This study however showed that herbicide spraying cost was not statistically significant different between types of maize. This confirms that the usage of herbicide was not reduced across the surveyed provinces aside from only GM maize areas in An Giang province. This reflected that maize growers still sprayed herbicides from one to three times with or without cultivated GM maize varieties because of their uncertainty of weed growth after three and four days and after 25-30 days or lack of information on benefits of new maize seeds.

**GM and Non-GM Maize: Output, Revenue and Net Profit**

In terms of production output, the results in table 5 below shows that average total revenue of maize production was ranged of 28,100.85±8,805.84 thousand dong. The difference is statistically significant between GM and non-GM maize varieties. Mean total revenue of GM maize was higher than that of non-GM maize corresponding 32,057.85±12,260.18 and 26,781.85±6,845.89 thousand dong respectively. The increase in GM maize output was mainly resulted by benefits of high selling price of cooperative contracts to traders, collectors in Xuan Loc and Cam My districts in Dong Nai province. Furthermore, a higher investment in fertilizers in Dong Nai and An Giang provinces also contributed to these expected revenues. In other words, average net profit of GM maize was higher than non-GM maize by 17,896.57±10,437.46 and 11,392.39±6,557.99 thousand dong respectively. These differences was statistically significant.

Observed results of profit-cost ratio (PCR) showed that the profit on investment of maize production was relatively low by 0.89±0.58 on average. The mean difference of the ratio was higher for GM maize rather than non-GM maize by 1.26±0.69 and 0.77±0.48 respectively. These results were statistically significant different between both types of maize. In explaining the correlation between land allocation and input, output factors was displayed in table 6. The relationship among total variable cost, total cost, total revenue and land allocation were strong and positive. The consequences were similar to the correlation between total cost and total revenue, total revenue and net profit, as well as net profit and profit-cost ratio. Nevertheless, the profit-cost ratio negatively correlated to maize land area, total variable cost and total cost.

## Conclusion

This study focused on the economic analysis of cost and profit comparison between GM and non-GM maize production in Southern Vietnam. On the basis of important indicators involving costs of production, revenue, profit and profit-cost ratio are measured to determine profitability and the worth investment in selected maize variety. Main findings are:

- Land allocation to GM and non-GM maize production was concentrated upon small and medium scales. Under this condition, the average land fragmentation was from one to two plots.

- Costs of GM maize production were significantly lower than ones of non-GM maize cultivation per hectare. The difference in cost was remarkable across provinces, especially in Dak Lak province.

- The high expenditures of maize seed cost, chemical costs (herbicide, pesticide), labor wages of weeding, chemical spraying were statistically significant different between both maize types. Of which, GM maize seed costs were obviously higher than non-GM maize seeds based on the large deviation in price. However, herbicide use was still highly maintained for both types of maize in Dak Lak and Dong Nai provinces.

- Indicators of total revenue, net profit and profit-cost ratio of GM maize cultivation reflected the higher profitability than compared to those of non-GM maize. Otherwise, the correlation was strong and positive between total revenue to profit and to profit-cost ratio. Profit positively correlated while maize area, total production cost negatively correlated to the profit-cost ratio.

## Recommendation

Though initial results presented relative benefits of GM maize variety utilization in the study areas. They should also be carefully considered as the evaluation is based on the major maize cropping season. Findings may change over time and over other cropping seasons, especially in large-scale farm size. There is still an essential consideration for more comparative studies in other regions in order to reflect more comprehensive assessment.

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Table 1 Land allocation for maize varieties by province (unit: hectare(s))

| Province | GM maize (n=74) | | | Non-GM maize (n=222) | | | t-value |
|---|---|---|---|---|---|---|---|
| | mean | ± | sd | mean | ± | sd | |
| **Dak Lak** | 0.61* | ± | 0.25 | 0.85* | ± | 0.36 | 3.9075 |
| **Dong Nai** | 0.87ns | ± | 0.34 | 0.94ns | ± | 0.29 | 0.8866 |
| **An Giang** | 0.43ns | ± | 0.19 | 0.49ns | ± | 0.21 | 0.7213 |
| **Total** | 0.69* | ± | 0.32 | 0.84* | ± | 0.35 | 3.3838 |

Source: Survey data, 2016

Note: * indicates the statistically significant level at 10% using two tailed t-test of two-group mean comparison; ns means non-significance; sd denotes standard deviation; n means number of observations.

Table 2 Costs of maize production on average per hectare (unit: 1000 VND)

| Variables | GM maize (n=74) | | | Non-GM maize (n=222) | | | t-value |
|---|---|---|---|---|---|---|---|
| | mean | ± | sd | mean | ± | sd | |
| **TVC** | 13,055.48$^{ns}$ | ± | 3,145.64 | 13,420.01$^{ns}$ | ± | 3,125.12 | 0.8676 |
| **TFC** | 343.15$^{ns}$ | ± | 421.26 | 384.33$^{ns}$ | ± | 506.86 | 0.6299 |
| **TC** | 14,161.28$^{*}$ | ± | 3,552.24 | 15,473.18$^{*}$ | ± | 2,987.44 | 3.1154 |

Source: Survey data, 2016

Note: * indicates the statistically significant level at 10% using two tailed t-test of two-group mean comparison, ns means non-significance; TVC is total variable cost, TFC is total fixed cost, TC is total cost; n means number of observations; sd denotes standard deviation. Costs are in Vietnam dong (VND), 1US$=22,300 dong in January, 2016.

Table 3 Total cost (TC) of maize production per hectare by provinces (unit: 1000 VND)

| Provinces | GM (n=74) | | | Non-GM (n=222) | | | t-value |
|---|---|---|---|---|---|---|---|
| | Mean | ± | sd | Mean | ± | sd | |
| **Dak Lak** | 12,527.34$^{*}$ | ± | 2,858.48 | 15,125.788$^{*}$ | ± | 2,952.83 | 4.8549 |
| **Dong Nai** | 15,543.31$^{ns}$ | ± | 3,826.21 | 15,863.40$^{ns}$ | ± | 2,141.70 | 0.4586 |
| **An Giang** | 16,578.92$^{ns}$ | ± | 1,831.87 | 17,871.43$^{ns}$ | ± | 4,140.65 | 0.8827 |

Source: Survey data, 2016

Note: * indicates the statistically significant level at 10% using t-test two-group mean comparison; ns denotes non-significance; sd means standard deviation; n means number of observations; Costs are in Vietnam dong (VND), 1US$=22,300 dong in January, 2016.

Table 4 Cost of input factors of maize production per hectare (unit: 1000 VND)

| Input factors | GM (n=74) | | | Non-GM (n=222) | | | t-value |
|---|---|---|---|---|---|---|---|
| | Mean | ± | sd | Mean | ± | sd | |
| **Total input cost** | | | | | | | |
| **- Seed costs** | 3,233.92* | ± | 1,180.27 | 1,899.40* | ± | 628.31 | -9.2973 |
| **- Fertilizer costs** | 6,728.55ns | ± | 2,543.18 | 6,582.42ns | ± | 2,634.44 | -0.4242 |
| **- Chemical costs** | 181.14** | ± | 62.45 | 306.85** | ± | 203.49 | 7.5206 |
| **Total labor costs** | | | | | | | |
| **+ *Field Cleaning*** | 618.04ns | ± | 369.56 | 654.58ns | ± | 333.28 | 0.6025 |
| **+ *Ploughing*** | 237.63ns | ± | 278.37 | 196.56ns | ± | 171.23 | -0.3791 |
| **+ *Lines, holes making*** | 478.57ns | ± | 438.74 | 502.50ns | ± | 611.65 | 0.2466 |
| **+ *Seed planting*** | 1,384.45ns | ± | 691.90 | 1,235.75ns | ± | 512.25 | -1.7000 |
| **+ *Irrigating*** | 266.86ns | ± | 75.25 | 235.59ns | ± | 179.31 | -0.6525 |
| **+ *Weeding*** | 000.00 | ± | 000.00 | 388.56** | ± | 108.32 | 0.0172 |
| **+ *Fertilizer application*** | 521.81ns | ± | 324.18 | 464.34ns | ± | 225.24 | -1.4154 |
| **+ *Herbicide spraying*** | 409.11ns | ± | 235.62 | 414.97ns | ± | 208.10 | 0.1902 |
| **+ *Pesticide spraying*** | 000.00 | ± | 000.00 | 238.72** | ± | 94.089 | 0.0359 |
| **+ *Harvesting*** | 1,877.80* | ± | 982.59 | 2,392.72* | ± | 539.44 | 4.2973 |
| **- Service costs** | 1,286.84ns | ± | 791.76 | 1,437.69ns | ± | 779.02 | 1.4227 |
| **- Other expenses** | 574.55ns | ± | 420.67 | 383.92ns | ± | 210.26 | -1.7009 |
| **Total fixed costs** | | | | | | | |
| **- Depreciation** | 334.14ns | ± | 424.13 | 357.33ns | ± | 502.61 | 0.3882 |
| **- Land tax** | 225.00ns | ± | 106.07 | 150.00ns | ± | 000.00 | -1.8898 |

Source: Survey data, 2016

Note: **, * indicates the statistically significant level at 5% and 10% respectively using t-test two-group mean comparison; ns denotes non-significance; sd means standard deviation; n means number of observations; Costs are in Vietnam dong (VND), 1US$=22,300 dong in January, 2016.

Table 5 Total revenue, net profit and profit-cost ratio between maize types (unit: 1000 VND)

| Variables | GM (n=74) | | | Non-GM (n=222) | | | t-value |
|---|---|---|---|---|---|---|---|
| | Mean | ± | sd | Mean | ± | sd | |
| **Total revenue (TR)** | 32,057.85* | ± | 12,260.18 | 26,781.85* | ± | 6,845.89 | -3.5233 |
| **Net profit (NP)** | 17,896.57* | ± | 10,437.46 | 11,392.39* | ± | 6,557.99 | -5.0393 |
| **Profit-Cost Ratio (PCR)** | 1.26** | ± | 0.69 | 0.77** | ± | 0.48 | -5.6067 |

Source: Survey data, 2016

Note: **, * indicates the statistically significant level at 5% and 10% respectively using t-test two-group mean comparison; sd means standard deviation; n means number of observations; Costs are in Vietnam dong (VND), 1US$=22,300 dong in January, 2016.

Table 6 Correlation coefficient matrix of planted maize area, input and output factors

| Variables | Marea | TVC | TFC | TC | TR | NP | PCR |
|---|---|---|---|---|---|---|---|
| **Marea** | 1.0000 | | | | | | |
| **TVC** | 0.8562*** | 1.0000 | | | | | |
| **TFC** | -0.0581** | -0.1345** | 1.0000 | | | | |
| **TC** | 0.9039*** | 0.9299*** | -0.1088** | 1.0000 | | | |
| **TR** | 0.7751*** | 0.7761*** | -0.0002ns | 0.8142*** | 1.0000 | | |
| **NP** | 0.4147*** | 0.3957*** | 0.1295** | 0.3927*** | 0.8342*** | 1.0000 | |
| **PCR** | -0.2269*** | -0.2569*** | 0.2178*** | -0.3083*** | 0.2543*** | 0.7045*** | 1.0000 |

Source: Field survey, 2016

Note: ***, **, * indicates statistically significant levels at 1%, 5% and 10% respectively, ns means non-significant, Marea is planted maize area, TVC is total variable cost, TFC is total fixed cost, TC is total cost, TR is total revenue, NP is net profit, PCR is profit-cost ratio.