The Comparative Risk and Income Analysis of the Cultivation of Cayenne Pepper, Big Red Chili, and Curly Chili on the Lombok Island

by Muhamad Siddik

Submission date: 16-May-2023 02:18AM (UTC-0500)
Submission ID: 2087638722
File name: 195906191984031001-1680686681-07_siddik__nongye_compressed.pdf (1.15M)
Word count: 11300
Character count: 54109

Nongye Jixie Xuebao

Transactions of the Chinese Society of Agricultural Machinery

ISSN: 1000-1298

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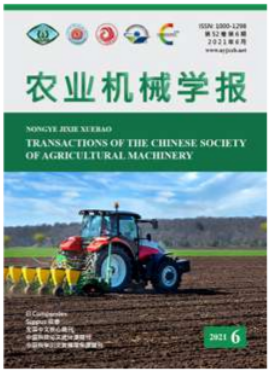

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Research article
Rural management and agricultural development: Trade

The Comparative Risk and Income Analysis of the Cultivation of Cayenne Pepper, Big Red Chili, and Curly Chili on the Lombok Island

Muhamad Siddik, Dwi Praptomo Sudjatmiko, Tajidan Tajidan, Bambang Dipokusumo, Anwar Anwar
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Abstract: The aim of this research is to develop a comparative model of production risk and price risk and determine its relation to the income from cayenne pepper, big chili, and curly chili farming in the tropical areas. To find the comparative model of production and price risk, an analysis of variance, standard deviation, and coefficient of variation between types of chili was carried out and the relationship between the level of risk and income by using a Pearson correlation analysis. The data were collected from 90 sampling units consisting of 30 sampling units for each type of chili farming. The sampling unit for each type of farming was selected using a simple random sampling technique, while the data were using structured interviews, in-depth interviews, and observations at each chili farming location. The research found that the production risk of cayenne pepper farming is lowest compared to the production risk of curly chili farming and big chili farming; conversely, the price risk of cayenne pepper is in the high-risk category compared to the price risk of big chilies and curly chilies.Pearson correlation analysis can be used to determine the relationship between the level of risk and chili farming income, the higher the production risk, the higher the income of cayenne pepper and curly chili farming. Meanwhile, the higher the production risk, the lower the income from big chili farming, while the higher the price risk, the lower the farming income.
Keywords: coefficient; correlation; deviation; farming; model

龙目岛辣椒、大红辣椒、卷辣椒种植的风险与收益比较分析

Muhamad Siddik, Dwi Praptomo Sudjatmiko, Tajidan Tajidan, Bambang Dipokusumo, Anwar Anwar
（马塔兰大学农业学院, 83124, 印度尼西亚）

摘要: 本研究的目的是开发生产风险和价格风险的比较模型，并确定其与热带地区辣椒、大辣椒和卷辣椒种植收入的关系。为了找到生产和价格风险的比较模型，使用皮尔逊相关分析对辣椒类型之间的方差、标准差和变异系数进行分析，并分析风险水平与收入之间的关系。数据收集自 90

Received: October 5, 2022 / Revised: November 7, 2022 / Accepted: December 3, 2022 / Published: December 30, 2022
Fund projects: The Rector of the University of Mataram and the Head of the Research and Community Service Institute (Research funding through the state non-tax revenue allocation in 2022)
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个抽样单位，其中每种辣椒种植类型有 30 个抽样单位。每种种植类型的抽样单位是使用简单的随机抽样技术选择的，而数据使用的是结构化访谈、深度访谈和每个辣椒种植地点的观察。研究发现，与卷辣椒种植和大辣椒种植相比，辣椒种植的生产风险最低；相反，与大辣椒和卷辣椒的价格风险相比，辣椒的价格风险属于高风险类别。皮尔逊相关分析可以确定风险水平与辣椒种植收入之间的关系，风险水平越高 生产风险大，辣椒和花椒种植的收入较高。同时，生产风险越高，大辣椒种植收益越低，而价格风险越高，种植辣椒收益越低。

关键词：系数; 相关性; 偏差; 农业; 模型

1 Introduction

Chili is one of the most important agricultural and food staples in Indonesia[1] because, in addition to being widely cultivated and a source of income for many residents, it is also used all the time and throughout the year by the people of Indonesia. Also, the government always monitors the development of this commodity[2] because it is a commodity that contributes to high inflation in Indonesia. This arises because the price of chili always fluctuates every year; in certain months, the price is very low; in other months, the price increases sharply[25].

The fluctuating price of chili is due to the erratic production and supply of chili[3], while the demand is relatively constant. At certain times, production and supply are extremely low, causing chili prices to rise sharply. Meanwhile, at other times, the production and supply of chili peppers is abundant, so the price of chili peppers drops drastically[4]. This condition causes the commodity crop of chili to face production and price risks that are quite high.

Theoretically, the courage of farmers to face agricultural risks determines their productivity and income from agriculture[5]. If farmers behave with fear of risk (risk *aversion*), the usage of resources (land, labor and other production facilities) is not carried out optimally, resulting in lower productivity and lower farm income. But if farmers are risk *takers*, then resource usage will be optimal for maximum productivity and income, but with the possibility of increased risk of loss. Therefore, to increase the productivity and income of chili cultivation, it is highly determined by the courage of farmers to face the risks of this crop.

In Indonesia, the types of chili that many farmers grow are cayenne pepper, big chili and curly chili[6]. On Lombok Island, the most cultivated type of chili is cayenne pepper. However, among the cayenne pepper plants, many farmers were also found to grow big red chilies or curly chilies in the same stretch and season. Farmers' choice in determining the type of chili plants to grow certainly has its own reasons, believed to be related to the risks and income of farming. This study develops a comparative model of production and price risks and determines its relation to the farming income of cayenne pepper, big chili, and curly chili in the tropical areas and the relationship between risk level and income on the Lombok Island.

2 Research Method

2.1 Research Subjects

This research was carried out on Lombok Island, West Nusa Tenggara Province, Indonesia. The research topics were the cultivation of cayenne pepper, big red chili, and curly chili, which were grown during the 2021/2022 rainy and dry seasons. On Lombok Island, the rainy season usually occurs from November to April; the dry season is from May to October[7].

2.2 Research Design

The research was designed using an explanatory method, that is, research that explains and relates one variable to another that is different but interrelated and produces a causal relationship[8].

The main variables that are connected and sought for correlation are the level of production and price risk with the farming income of each type of chili.

The research locations were determined in stages (multistage purposive sampling) starting from the district, sub-district to village levels. The selection of districts was based on the production centers of the three types of chili, thus, East Lombok Regency was selected. Additionally, three sub-districts/villages were selected which cultivated the three types of chili; each sub-district/village is expected to represent lowland (< 200 mpl), midland (200-500 mpl) and highland areas (> 500 mpl). The location selection was based on the height of the area and the results of previous research that the altitude of the area affects the production and income of

cayenne pepper farming and this is expected to apply to big red chili and curly chili farming (Fig. 1). On the basis of these considerations, Jerowaru Village in Jerowaru District was chosen to represent the lowland area, Kalijaga Village in Aikmel District to represent the midland area, and Pringgasela village in Pringgasela District to represent the highland.

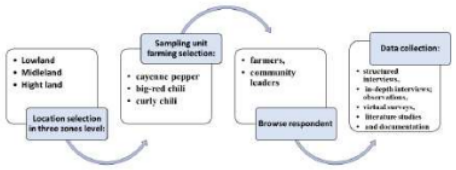

Fig. 1 Stages of the research

2.3 Research Respondents

Farmers who were the object of research were farmers who cultivate cayenne pepper, big red chili, and curly chili during the rainy season and/or dry season in 2021/2022 and had experience cultivating these chilies for at least three growing seasons. Initial information about the chili farmers was obtained from farmer groups in each sample village. Then, we randomly selected (random sampling) each of 10 respondent farmers with the criteria according to the aforementioned provisions. Therefore, this research obtained 90 respondents.

2.4 Data Collection

The data collection was carried out by combining several methods simultaneously, namely the method of structured interviews using a list of questions[10], in-depth interviews, field observations, virtual surveys, literature studies, and documentation. The structured interview is aimed at the surveyed farmers who grow cayenne pepper, big red chili, or curly chili. The in-depth interviews were aimed at community leaders who know about chili cultivation and the problems it faces, as well as government policies related to agricultural development.

2.5 Procedure for the Data Analysis

The farm risk studied is the production risk and the price risk. The measurement of both risks uses the variance, the standard deviation and the coefficient of variation[11]. Production and price variations as measures of production and price risks are based on the experience of farmers conducting chili cultivation activities before. The procedure for finding a comparative model is shown in Fig. 2.

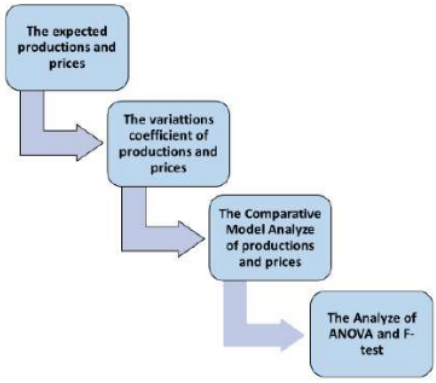

Fig. 2 Stages of the comparative production risk and price risk analysis

2.5.1 Expected Production and Prices

The production and price of each type of chili was measured using the following formula:

$$\mu_i = q_{ih} Q_{ih} + q_{ir} Q_{ir} + q_{in} Q_{in}, \ldots\ldots \quad [3.1]$$

$$\sigma_i^2 = q_{ih} [Q_{ih} - \mu_i]^2 + q_{ir} [Q_{ir} - \mu i]^2 + q_{in} [Q_{in} - \mu_i]^2 \ldots \quad [3.2]$$

$$\theta_i = q_{ih} P_{ih} + q_{ir} P_{ir} + q_{in} P_{in}, \ldots\ldots\ldots\ldots\ldots\ldots \quad [3.3]$$

$$\varphi_i^2 = q_{ih} [P_{ih} - \theta_i]^2 + q_{ir} [P_{ir} - \theta_i]^2 + q_{in} [P_{in} - \theta_i]^2 \ldots \quad [3.4]$$

where:

Q = Production of each type of chili (kg/Ha)
μ_i = Expected production of each type of chili (kg)
σ_i^2 = Variance or risk of production of each type of chili
P = Price of each type of chili (IDR/kg)
θ_i = Expected price of each type of chili (IDR/kg)
φ_i^2 = Price variation or risk for each type of chili
i = sample or respondent i
q = Production opportunity or price opportunity for each type of chili (%)
h, r,n = Shows high (h), normal (r) and low (n) production opportunities or prices for each type of chili

2.5.2 The Variation Coefficient of the Production and Prices

Additionally, to analyze the level of production risk and price risk for each type of chili, the coefficient of variation is used, with the formula:

$$CVqj = \frac{\sigma j}{\overline{Qj}} \quad [3.5]$$

$$CNpj = \frac{\Theta j}{\overline{pj}} \quad [3.6]$$

where:

CVqj = Production variation coefficient for each type of chili
σι_ = Standard deviation of production for each type of chili
CVpj = Price variation coefficient for each type of chili
Θj_ = Standard deviation of the price of each type of chili
j = Type of chili (1 = cayenne pepper, 2 = big-red chili and 3 = curly chili)

If the coefficient of variation of CVqj or CVpj is greater than 0.5, the production or price risk is in the high category; but if it is less than or equal to 0.5, it is included in the low-risk category.

2.5.3 The Comparative Analysis of the Production and Prices

Tab. 1 The comparative model of production risk

Comparison	Cayenne Pepper	Big Red Chili	Curly Chili
Cayenne Pepper	1.000	CMq21 = CVq2/CVq1	CMq31 = CVq3/CVq1
Big Red Chili	CMq12 = CVq1/CVq2	1.000	CMq32 = CVq3/CVq2
Curly Chili	CMq13 = CVq1/CVq3	CMq23 = CVq2/CVq3	1.000

Tab. 2 The comparative model of price risk

Comparison	Cayenne Pepper	Big Red Chili	Curly Chili
Cayenne Pepper	1.000	CMp21 = CVp2/CVq1	CMp31 = CVp3/CVq1
Big Red Chili	CMp12 = CVp1/CVq2	1.000	CMp32 = CVp3/CVq2
Curly Chili	CMp13 = CVp1/CVq3	CMp23 = CVp2/CVq3	1.000

Notes: CMq - comparative model of production risk; CMp - comparative model of price risk; CVq - production coefficient variation; CVp - price coefficient variation; CM - comparative model

2.5.4 The Analysis of ANOVA and F-Test

To compare the risks of cayenne peppers, big red peppers, and curly peppers, use the ANOVA statistical test (analysis of variance) or the F test; then proceed with the LSD (least significant difference) test. ANOVA or F test is used to analyze and test the difference in the average count of the sample as a whole (Tab. 3).

Tab. 3 Differences in ANOVA and F-test of risks of cayenne pepper, big red chili, and curly chili crops

Origin of variance	SS	DF	MS	F-Test
Between Groups (b)	SS_b	k-1	$\frac{SS_b}{k-1}$	$\frac{MS_b}{MS_W}$
In group (w)	$SS_w = SS_T - SS_b$	k(n-1)	$\frac{SS_W}{k(n-1)}$	
Total	SS_T	nk-1		

Notes: DF - degrees of freedom; SS - sum of squares; MS - sum of mean squares; SS_T - total square sum; SS_b - sum of squares between the groups; SS_w - sum of squares in the group; n - number of data or samples; k - number of groups or types of chili

The decision criterion is if F count > F table at an error rate (α) of 10%, then there is a difference in the risk or income of cayenne pepper, big red chili, and curly chili farming. Conversely, if F count ≤ F table, then there is no difference in risk or income for the three types of chili.

2.6 Farming Income Analysis

Furthermore, farm income is measured by reducing the value of production, considering all production costs. The value of production is the product multiplied by the price of production.

$$Qj = \sum_{k=1}^{m} Q_k \quad (3.7)$$

$$TC = VC + FC \quad (3.8)$$

$$\prod j = \sum_{k=1}^{m} P_k x\ Q_k - TC_k \quad (3.9)$$

where:

Q - production of each type of chili (kg/Ha);
∏ - farming income for each type of chili (IDR000);

P - price of each type of chili (IDR/kg);
TC - total cost or total cost of each type of chili (IDR);
VC - variable costs (IDR);
FC - fixed costs (IDR);
j - type of chili (cayenne pepper, big red chili, curly chili);
m - number of times harvested for each type of chili;
k - the k-th harvest (k =1,2,3, ……m) of each type of chili.

To compare the risks and returns of growing cayenne peppers, big red peppers, and curly peppers, use the ANOVA statistics.

If the results of the ANOVA or F test show that there is a significant difference, then proceed to the LSD test, to individually test the difference in risk or farm income for each type of pepper. To calculate the LSD value, some data are needed from the ANOVA calculations, namely MS_E (*mean square error*) data, df (degrees of freedom), r (number of samples for each group or type of chili) and Student's t tables. The full formula of LSD is as follows:

$$LSD_{\alpha} = (t_{1/2\alpha,\, df}) \cdot \sqrt{\frac{2(MS_E)}{r}} \quad (3.10)$$

The decision criterion, if the difference between two variables is greater than LSD_{α}, the two variables (agricultural risk or income) show a significant difference. But if the difference between them is less than or equal to $LSD_{\alpha,,}$ they are not significantly different[12].

Additionally, to analyze the relationship between production risk and price risk with Farming Income for each type of chili, the Pearson correlation coefficient (r) is used with the following formula:

$$r = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{[\sum (x-\bar{x})^2][\sum (y-\bar{y})^2]}} \quad (3.11)$$

where:
X - production risk or price risk for each type of chili;
Y - farming income for each type of chili.

3 Result

There are differences in risks of cultivation of cayenne pepper, big red chili, and curly chili.

3.1 Production Risk

The production risk analyzed by the production variance is measured by adding the difference in the production squares with the production expectations multiplied by the probability of each event (high, normal, and low production) based on the experience in chili cultivation.

Tab. 4 Production risks of farming cayenne pepper, big red chili peppers, and curly chili (Primary data analysis, 2022)

No.	Description	Cayenne Pepper	Big Red Chili	Curly Chili
1	Production Variations	6,272,348	7,699,396	6,019,674
2	Standard Deviation of Production	2,504	2,775	2,454
3	Production Variation Coefficient	0.45	0.51	0.49

Additionally, from the variance value obtained, the standard deviation and the coefficient of variation are calculated to determine the level of risk faced by farmers. The results of the production risk analysis of cayenne pepper, big red chili, and curly chili can be seen in Tab. 4.

Tab. 5 Comparative analysis of production risks of farming cayenne pepper, big red chili peppers, and curly chili (Primary data analysis)

Comparison	Cayenne Pepper	Big Red Chili	Curly Chili
Cayenne Pepper	1.00	1.33*	1.09*
Big Red Chili	0.88*	1.00	0.96
Curly Chili	0.92*	1.04	1.00

The results of the comparative analysis of production risk between chili types are shown in Tab. 5 and the comparative significance can be read in Tab. 6. The risk of producing big red chili is almost the same as the risk of producing curly chili, and production risk of cayenne pepper is lower than curly chili and big red chili or big red chili highest production risk.

Tab. 6 The comparative test (LSD) results on the risks of the cultivation of cayenne pepper, big red chili, and curly chili (Primary data analysis, 2022)

Comparison		Mean Differences (IJ)	Std. Error	Sig.	95% Confidence Intervals	
					Lower Bound	Upper bound
Cayenne pepper	Big red chili	-.06367 *	.01060	.000	-.0847	-.0426
	Curly chili	-.04733 *	.01060	.000	-.0684	-.0263
Big red chili	Cayenne pepper	.06367 *	.01060	.000	.0426	.0847
	Curly chili	.01633	.01060	.127	-.0047	.0374
Curly chili	Cayenne pepper	.04733 *	.01060	.000	.0263	.0684

Continuation of Tab. 6					
Big red chili	-.01633	.01060	.127	-.0374	.0047

* The mean difference is significant at the 0.05 level.

3.2 Price Risk

Price risk is also analyzed in the same way as production risk, but the results of the analysis are contradictory. Tab. 6 shows that the coefficient of variation of prices (CVp) for the cayenne pepper crop is the highest (0.57) compared to the big red pepper (0.49) and the curly pepper (0.46), although both also have a fairly high coefficient of variation.

Tab. 7 Price risk for cayenne pepper, big red chili, and curly chili (Primary data analysis, 2022)

No.	Description	Cayenne pepper	Big red Chili	Curly Chili
1	Price Variation (IDR x1000)	182,631	64,434	68,134
2	Price Standard Deviation	13,514	8,027	8,254
3	Price Variation Coefficient	0.57	0.49	0.46

The results of this analysis indicate that the cayenne pepper crop in the Lombok Island is in the high price risk category (CVp > 0.5), while big red chili peppers and curly chili peppers are excluded from it. Although the coefficient of variation is quite high, it is still below 0.50. The results of this study are consistent with the results of previous studies, that the price risk of cayenne pepper in the cayenne pepper production centers in the Lombok Island, both in the highlands, mid-plains, and lowlands, is listed in the high-risk category.

Tab. 8 Comparative analysis of price risks of farming cayenne pepper, big red chili peppers, and curly chili (Primary data analysis)

Comparison	Cayenne Pepper	Big Red Chili	Curly Chili
Cayenne Pepper	1.00	0.85*	0.81*
Big Red Chili	1.16*	1.00	0.94
Curly Chili	1.23*	1.07	1.00

The price risk of cayenne pepper is significantly larger than that of big red chili and curly chili (Tab. 8).

Tab. 9 Price risk from comparative test results (LSD) for cayenne, big red chili, and curly chili (Primary data analysis, 2022)

Comparison		Mean Differences (IJ)	Std. Error	Sig.	95% Confidence Intervals	
					Lower Bound	Upper bound
Cayenne pepper	Big red chili	.08367 *	.01583	.000	.0522	.1151
	Curly chili	.11267 *	.01583	.000	.0812	.1441
Big red chili	Cayenne pepper	-.08367 *	.01583	.000	-.1151	-.0522
	Curly chili	.02900	.01583	.070	-.0025	.0605
Curly chili	Cayenne pepper	-.11267 *	.01583	.000	-.1441	-.0812
	Big red chili	-.02900	.01583	.070	-.0605	.0025

* The mean difference is significant at the 0.05 level.

If the difference in price risk of curly peppers, big red peppers, and cayenne pepper is tested statistically with the LSD test at a confidence level of at least 90 percent, all three types of peppers have a significantly different price risk, both between cayenne pepper, big red chili, and curly chili peppers or between big red chili and curly chili peppers (Tab. 9).

Although the results of the analysis and the statistical tests of production and price risks in Tab. 6 show differences in the level of risk faced, in general, all three show quite high production and price risks, as indicated by the coefficients of variation. However, the big red chili possible loss caused by production risk is faced by the big red chili crop, then the curly chili crop, and the least likely by the cayenne pepper crop. On the other hand, the big red pepper possible loss caused by price risk is faced by the cayenne pepper crop, then the big red and small chili crop by the curly chili crop.

3.3 Differences in Farm Income for Cayenne Pepper, Big Red Chili, and Curly Chili

This study assumes that when choosing and conducting chili cultivation activities, farmers are oriented to obtaining the maximum income or profit. Achieving this objective is highly dependent on the production, price, and costs. The difference in income for the three types of chili cultivation also depends on these three factors.

3.3.1 Production and Prices

If the seasonal production level is above, calculated on average per year, then the cayenne pepper production level in 2021/2022 will be the highest, namely an average of 4.3 tonnes/ha, then big red chili 4.0 tons/ha and curly pepper 3.9 t/ha. Of course, the level of production of the three

types of chili is irrelevant for the comparison, but compared to the production of similar chilies in the previous year in East Lombok Regency, it seems that the chili production in 2021/2022 has decreased considerably.

Tab. 10 Average production and prices of cayenne pepper, big red chili, and curly chili (Primary data processed, 2022)

No.	Season	Cayenne pepper		Big red chili		Curly chili	
		Production (kg)	Price (IDR/kg)	Production (kg)	Price (IDR/kg)	Production (kg)	Price (IDR/kg)
1	Rainy season	3,539	41,061	3,295	24,171	3,093	30,736
2	Dry season	5,054	14,611	4,711	16,984	4,603	13,648
3	Average/Year	4,296	27,836	4,003	20,578	3,848	22,192

The East Lombok Regency BPS data in figures (2022) shows that the productivity of cayenne pepper in East Lombok Regency in 2021 is 7.8 tonnes/ha and big red chili (including curly chili) is 10.8 tons/ha. Relatively the same results were also found in the research by [3] that the productivity of cayenne pepper in the areas of the chili production center in East Lombok Regency during the rainy season reaches 7.6 ton/ha and during the dry season reaches 11.2 ton/ha. This difference indicates that chili productivity on Lombok Island is determined by location, weather conditions, and other external factors.

3.3.2 Commercial Costs

Farm costs are calculated from the total expenditure of farmers, both implicitly within the farmer's family and explicitly from outside the farmer. The results of the analysis show that the cost of growing cayenne pepper is higher than the cost of growing big red chili peppers and curly chili peppers, especially during the rainy season.

Tab. 11 Average costs of cayenne pepper, big chili, and curly chili (IDR000/ha) (Primary data processed, 2022)

No.	Description	Cayenne pepper		Big red chili		Curly chili	
		Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season
	A. Variable Costs	42,074	30,689	33,159	30,991	31,907	26,508
1	Production facilities	16,396	13006	13,267	13,471	11,885	11.188
2	Labor	13,212	10,555	9.117	8,298	8,397	7,047
3	Cost of other input production	12,466	7.127	10,775	9,223	11,625	8,273
	B. Fixed Costs	14,240	12,257	11,329	11,427	11.173	11,390
1	Land lease	13.178	11,082	10,597	10,490	9,981	10,236
2	Land tax	247	215	189	208	193	150
3	Water fee	120	410	171	316	460	489
4	Shrinkage	695	551	373	414	539	516
	Totals (A+B)	56,314	42,946	44,488	42,419	43,080	37,899

In the rainy season, the cost of growing cayenne pepper is IDR 56 million/ha, while the average crop of big red chili is IDR 44 million/ha and curly pepper IDR 43 million/ha. During the dry season, the cost of growing cayenne pepper is not much different from other types of chili, namely cayenne pepper of IDR 43 million/ha, big red chili IDR 42 million/ha and curly pepper IDR 37 million/ha (Tab. 11).

The agricultural costs that are mainly incurred by farmers are variable costs consisting of ordinary production facilities, in the form of seeds, fertilizers, growth stimulants, and drug costs, then labor costs and other support facilities like plastic mulch and stakes. These variable inputs cost about 70% of total farm costs. Although fixed inputs consist of income and land taxes, equipment depreciation, water costs, and interest on loan capital (30%), no farmers used loan capital in their farm business. The fixed cost incurred by many farmers is land rent. The results showed that the land rent in the research area, calculated per hectare, ranged between IDR 15 million and IDR 25 million per year or around IDR 7.5 million to IDR 12.5 million per chili growing season. But because most farmers cultivate their own land, this implicit cost is not seen as a burden on farmers.

3.3.3 Income and Farming Efficiency

Although the chili production in the Lombok Island in 2021/2022 has decreased sharply compared to the previous year because this decrease was offset by a fairly high increase in chili prices during the rainy season, farm income obtained is still quite high and farming is considered efficient.

Tab. 12 Average production, prices, production value, production costs, and farm income (Primary data analysis, 2022)

No.	Component	Cayenne pepper		Big red chili		Curly chili	
		Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season
1	Production (kg)	3,539	5,054	3,295	4,711	3,093	4,603
2	Price (IDR/kg)	41,061	14,611	24,171	16,984	30,736	13,648
3	Production Value (IDR.000)	145,297	73,843	79,655	80008	95,071	62,825
4	Production Cost (IDR.000)	56,314	42,946	44,488	42,419	43,080	37,899
5	Revenue (IDR.000)	88,983	30,897	35,167	37,589	51,991	24,927
6	RC Ratio	2.58	1.72	1.79	1.89	2,21	1.66

The highest income and agricultural efficiency in the rainy season is obtained with the cultivation of cayenne pepper, which reaches IDR 89 million/ha with a CR ratio of 2.58; then the curly chili crop IDR 51 million/ha with RC 2.21; the lowest is the income from the big red chili crop, which amounts to IDR 35 million/ha with a RC ratio of 1.72. In the dry season the opposite occurs, the highest income is obtained by the big red chili cultivation, which is IDR 38 million/ha with a RC ratio of 1.89, then the cayenne pepper crop is IDR 31 million/ha with a RC ratio of 1.72; and the smallest obtained from the cultivation of curly pepper is IDR 25 million/ha with a RC ratio of 1.66 (Tab. 12).

When income from the aforementioned chili pepper crop is compared between the rainy season and the dry season, the biggest difference is in the cayenne pepper crop, which reaches IDR 58 million/ha; then curly pepper IDR 27 million/ha Meanwhile, for the big red chili crop, the difference is less than IDR 3 million/ha. This means that the big red chili crop has a relatively stable income between the rainy and dry seasons, while the cayenne pepper and curly chili crops are very volatile. This indicates that the cayenne pepper and curly chili crop have a high-income risk, while chili cultivation has low income risk.

3.3.4 Commercial Rent

If the above seasonal farm income is calculated as an average per year, then the cayenne pepper farm income is an average of IDR 59.19 million/ha, the average big red chili costs IDR 37.82 million/ha and curly pepper with an average of IDR 37.10 million/ha. To ensure that there is a difference in the income of the three chili growing businesses, a statistical test was carried out with the LSD test.

Tab. 13 Comparative test results (LSD) on farm income from cayenne pepper, big red chili, and curly chili (Primary data processed, 2022)

Comparison		Mean Difference (IJ)	Std. Error	Sig.	95% Confidence Intervals	
					Lower Bound	Upper bound
Cayenne pepper	Big red chili	21367.133 *	6618730	002	8211.69	34522.58
	Curly chili	22082.767 *	6618730	001	8927.32	35238.21
Big red chili	Cayenne pepper	-21367.133 *	6618730	002	-34522.58	-8211.69
	Curly chili	715,633	6618730	.914	-12439.81	13871.08
Curly chili	Cayenne pepper	-22082.767 *	6618730	001	-35238.21	-8927.32
	Big red chili	-715,633	6618730	.914	-13871.08	12439.81

* The mean difference is significant at the 0.05 level.

Based on the results of the LSD test in Tab. 11, it is conclusive (99%) that the income from the cayenne pepper crop in the Lombok Island is higher and convincingly differs from the income from the big red chili pepper crop and curly chili. Meanwhile, the incomes from the big red chili crop and the curly chili do not show a convincing difference. The results of this trial provide an explanation for the reasons why farmers in the Lombok Island, especially in the East Lombok Regency, prefer to plant bird's eye chilies instead of big red or curly chilies.

3.4 Relationship between Production and Price Risks and Farming Income

In the cultivation of cayenne pepper, big red chili, and curly chili, the production risk during the rainy season is on average higher than in the dry season, which is characterized by a decrease in production, but the decrease in production in the cultivation of cayenne pepper and curly pepper during the rainy season is followed by a sharp rise in prices, strong enough that earned farm income is higher than in the dry season, during which production risk is lower. Meanwhile, big red chili pepper production risk is indicated by a decline in production during the

rainy season, which is not followed by an adequate price increase, as is the case with cayenne pepper and curly chili. The price increases that occur cannot cover the decrease in production or production risks that occur, and the income obtained is lower than in the dry season, where production risks are lower.

Tab. 14 Risk-to-return test results for cayenne pepper, big red chili, and curly chili (Primary data processed, 2022)

Type of Chili	Variable Correlation	Coef Value. Correlation	Significance Test (P-Value)	Strength Connection
1.Cayenne pepper	Production-Risk-Income	0.339	0.067*	Less strong
	Price Risk – Income	-0.518	0.003***	Very strong
2. Big red chili	Production-Risk - Income	-0.404	0.027**	Less strong
	Price Risk – Income	-0.021	0.265	Less strong
3. Curly chili	Production-Risk - Income	0.071	0.708	Less strong
	Price Risk - Income	-0.599	0.001**	Very strong

4 Discussion

4.1 Productions Risk

Tab. 4 shows the results of the analysis that the coefficient of variation of production (CVq) of the three types of chili is quite high, but the highest is the big red chili (0.51), then the curly chili (0.49) and the most-low is cayenne pepper (0.45). This means that the chili crop production on the island of Lombok is quite risky, but the big red chili crop is included in the high-risk category (CVq > 0.50), while the curly chilies, especially the allspice cayenne, are still included in the low production risk category.

The production is the total yield of chili as a whole from the first to the last harvest, converted into units of hectares. The price is the average value of production per kilogram of chili received by farmers from the first to the last harvest. The results show that the production of cayenne pepper, big red chili, and curly chili in 2021/2022 differs quite a bit between the rainy and dry seasons, where the rainy season production is lower than the dry season. The production of cayenne pepper in the rainy season is 3.5 tons/ha and in the dry season - 5.1 tons/ha; big red chili production in the rainy season is 3.3 tons/ha and in the dry season - 4.7 tons/ha; curly pepper production rate in the rainy season is 3.1 ton/ha and in the dry season - 4.6 ton/ha (Tab. 10).

The average cayenne pepper production in Thailand is 13.96 tons, higher than the cayenne pepper production on Lombok Island (3.5 tons/ha). In Thailand, environmentally friendly technology has been implemented with an environmental index of 0.0142[13]. The low production of cayenne pepper on Lombok Island is suspected as a result of pest disturbances, the application of conventional technology, poor pest management practices, and the use of toxic. [14] state that Indonesia can produce curly chilies, each tree can produce 0.75 - 1 kg/harvest period. Such a low production achievement means a high level of risk. As explained by [15] that production and cost risks are caused by poor pest management and the low quality of pest control management by farmers.

The results of the LSD test on the differences in the risk of cayenne pepper, big red chili, and curly chili also show that the risk of cayenne pepper production is lower and significantly different from the risk of big red chili production, including curly pepper, with a confidence level of more than 95% (α = 5%). Meanwhile, there is no convincing difference between the production risks of big red and curly peppers at this level of confidence (Tab. 7).

The lower value of the coefficient of variation of cayenne pepper production indicates that the cayenne pepper farm is better able to control the risk (variation) of production, compared to curly pepper farm, more than big red chili farm.

4.2 Price Risk

The results of this study are different from the results of [16] in the Sumberrejo district, showing no significant difference between the production risk and the income risk of the cultivation of big red chili and cayenne pepper, but the price risk of big red chili is higher than the cayenne pepper price risk. This condition shows that each region has a different potential in the cultivation of basic chili products. However, the low risk of cayenne pepper production is supported by the research results of [17] and [18] who found that the risk of cayenne pepper production was low, which is why the cultivation of cayenne pepper is considered a profitable and viable agricultural business[17].

Farmers are affected by transaction and price risks caused by oversupply. Price risk can be avoided by selecting the right marketing channels[19]. In accordance with the results of this study, the decline in chili production compared to last year's production impacted increasing chili prices. Although the production of chili in 2021/2022 has decreased drastically, the sale

price has increased considerably, especially during the rainy season. As it happened in the cultivation of cayenne pepper; the price of cayenne pepper received by farmers in 2020/2021 during the rainy and dry seasons is an average of IDR 20 thousand/kg and IDR 16 thousand/kg[20] the average price received by farmers during the rainy season is IDR 41 thousand/kg and in the dry season an average of IDR 15 thousand/ha. Price risk follows the volatility of retail chili prices. The traders hope that building up somewhat higher margins will offset the price risk for stockholders[21].

Therefore, although during the rainy season, the level of production of farmers falls drastically, farmers do not feel a loss because it is covered by a sharp increase in sales prices. In contrast to the dry season, production did not increase much, but prices fell sharply to around IDR 15 thousand/kg less than in 2021, IDR 16 thousand/kg. Differences or fluctuations in chili prices during the rainy and dry seasons occur for all types of chili, but the most marked difference is cayenne pepper that reaches around IDR 26 thousand/kg, and curly chili reaches around IDR 17 thousand/kg. For big red chilies, the price difference is relatively small, around IDR 7,000/kg. This difference indicates that the annual price risk for the three types of chili is different, the highest price risk is faced by the cayenne pepper crop, then the curly chili, and the lowest is faced by big red chili[18].

4.3 Correlation between Production Risk and Farming Income

The farmers who are willing to business on chili farming that is indicate they have the courage to face risks. The attitude toward risk is related to income because farmers who dare to face risks have the opportunity to earn income. Therefore, it should be suspected that there is a relationship between the level of risk and income. Production risk is related to climate risk and loss of income borne by farmers due to crop failure, heavy rain, and wind[22].

Correlation analysis shows that the risk of cayenne pepper production is positively related to farm income. This means that the higher the production risk, the higher the income from the chili crop. On the other hand, cayenne pepper price risk is negatively related to farm income. The higher the price risk, the lower the income from the cayenne pepper crop. The same happened with the curly pepper crop, where production risk had a positive relationship with farm income, while price risk and farm income had a negative relationship. Unlike big red peppers, both production risk and price risk are negatively related to farm income (Tab. 14).

4.4 Correlation between Price Risk and Farming Income

A decrease in income occurs due to either a decrease in prices or a decrease in the level of production. This shows that farmers can reduce income risk by reducing the relative importance of fixed cost allocation to the farm[23].

The complexity of revenue risk is closely related to production risk and price risk because revenue risk can be part of production risk, on the one hand, because it depends on farmers' decisions, and on the other hand, can be linked to markets or prices[24].

On the other hand, in the dry season, the average price risk faced by farmers of bird's eye chili peppers, big red chili peppers, and curly chili peppers increases and is greater than that in the rainy season, marked by a sharp fall in prices[9]. This drastic price reduction was not followed by a sharp increase in production, so income earned was low, even for cayenne pepper and chili peppers, much lower than the income earned during the rainy season.

The existence of a positive and negative relationship between production risk and price risk with farm income indicates that high risk is not always followed by the possibility of low income. Also, low risk is not always followed by high farm income. What is more decisive and logical is the courage of farmers despite the risks of agriculture. The more courageous farmers are in facing the risks that are marked by the more intensive use of production inputs, the more likely farmers are to earn higher incomes or profits[9].

5 Conclusions and Implications

5.1 Conclusions

The comparative model of production and price risk could be used to analyze the comparison of the risk level of various types of chili farming in the tropical areas. The risk of cayenne pepper production is the lowest compared to the production risk of curly chili farming and big red chili farming, conversely, the price risk of cayenne pepper is in the high-risk category compared to the price risk of big red and curly chilies. The higher the production risk of cayenne pepper and curly chili farming, the greater the farming income[8]; the higher the production risk, the lower the big chili farming income; the higher the price risk, the lower the farming income.

5.2 Implications

Cayenne pepper farming and curly chili farming are risky but profitable businesses in an effort to increase farmers' income and for the government to ensure price stability and control inflation, while big chili farming has relatively stable prices. However, it is not profitable for farmers. Therefore, the planting area is limited according to market demand.

Acknowledgment

Thank you very much to the Rector of the University of Mataram and the Head of the Research and Community Service Institute for facilitating research funding through the state non-tax revenue allocation in 2022, so that we can publish our manuscript on the research results.

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