第 53 卷 第 12 期 农 业 机 械 学 报 Vol. 53 No. 12
2022 年 12 月 Transactions of the Chinese Society of Agricultural Machinery Dec. 2022

Research article
Rural management and agricultural development: Trade

The Analysis of the Risk Production and the Price of the Cayenne Pepper at Various Altitudes

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Abstract: The specific objectives achieved in this study are: to determine the productivity and income from the cayenne pepper crop at various altitudes on the island of Lombok, the level of risk faced, the behavior of farmers against risks and the relationship on effect of production risk with altitude, price risk with growing season, and production inputs for farm output and income. The study used an explanatory method in three villages that were central to cayenne pepper production at different altitudes. The respondents were farmers who grew cayenne peppers at the research site. The number of respondents was determined in 45 selected agricultural units using the accidental sampling technique. The results showed that the highest productivity of cayenne was found in the lowlands (11,133 kg/ha), then in the medium lands - 10,277 kg/ha, and the lowest in the highlands (9,400 kg/ha). Farm income in lowland was 92.8 million rupees per hectare, in medium lands it was 79.1 million rupees per hectare and the lowest was 73.0 million rupees per hectare in highland. Production risk was low with the highest coefficient of variation in the highlands (0.46), in the midlands - 0.42, and the lowest in the lowlands - 0.34. For its part, the price risk was classified as high with a coefficient of variation in the highlands of 0.62, 0.61 in the medium lands, and 0.60 in the lowlands. Farmers' behavior in coping with production and price risks was considered a risk taker. Cayenne pepper crop production on Lombok Island could still be increased by increasing the area of farmland, labor, urea or ZA fertilizers, SP36 fertilizers and by increasing the ability of farmers to manage agricultural risks.
Keywords: productivity; land area; risk

不同海拔辣椒的风险生产与价格分析

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Received: October 17, 2022 / Revised: November 12, 2022 / Accepted: December 10, 2022 / Published: December 30, 2022
Fund projects: The Rector, Director of the Community Service and Research Institute, Dean of the Faculty of Agriculture, University of Mataram
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摘要:
本研究实现的具体目标是：确定龙目岛不同海拔辣椒作物的生产力和收入、面临的风险水平、农民应对风险的行为以及生产风险与生产风险的关系海拔高度、生长季节的价格风险以及农业产出和收入的生产投入。该研究在三个不同海拔高度的辣椒生产中心村庄使用了一种解释方法。受访者是在研究地点种植辣椒的农民。使用偶然抽样技术在45个选定的农业单位中确定了受访者人数。结果表明，辣椒的最高生产力出现在低地（11,133公斤/公顷），其次是中等土地-10,277公斤/公顷，高地最低（9,400公斤/公顷）。低地的农场收入为每公顷9280万卢比，中等地为每公顷7910万卢比，最低的是高地每公顷7300万卢比。生产风险低，变异系数最高的是高地(0.46)，中部- 0.42，低地最低-0.34。就其本身而言，价格风险被归类为高，高地的变异系数为0.62，中等地为0.61，低地为0.60。农民应对生产和价格风险的行为被认为是风险承担者。通过增加农田面积、劳动力、尿素或ZA肥料、SP36肥料以及提高农民管理农业风险的能力，仍然可以增加龙目岛的辣椒作物产量。
关键词：生产率; 土地面积; 风险

1 Introduction

The chili plant is one of the most important horticultural products in Indonesia because in addition to being widely cultivated and a source of income for many residents, it is also used every time and throughout the year by the international community[1]. Additionally, the government constantly monitors the development of this commodity, as chili is a commodity that contributes to high inflation in Indonesia and ASEAN countries[2,3]. This arises because the price of chili always fluctuates every year[4]; in certain months the price is very low and in other months the price increases considerably[5].

The fluctuation in the price of cayenne pepper is due to the uncertainty in the production and supply of cayenne pepper, while the demand is relatively constant[6,21]. At certain times, production and supply are very low, causing cayenne prices to rise considerably. At other times, the production and supply are abundant, so the price of cayenne drops drastically[7]. This situation means that the exploitation of chili commodities faces a high production and price risk. The courage of farmers to face the risks of agriculture theoretically determines the productivity and income of agriculture. If farmers behave with fear of risk (risk *aversion*), the use of resources (land, labor, and other production facilities) is not optimally done, causing the productivity and income of farmers to decrease. The farm is lower than what can be produced[7]. However, if farmers behave risk-aversely (*risktakers*), then resource use will be optimal for maximum productivity and income, but with the possibility of increased risk of loss[8]. Therefore, to increase the productivity and income of pepper cultivation, it is highly determined by the courage of farmers to face the risks of farming.

The type of chili that is most widely grown on the island of Lombok is cayenne pepper, which is popularly called cayenne pepper. Of the 6,181 hectares of chili area, 5,619 hectares or about 90.91 percent are cayenne pepper, while other types of chili are only 562 hectares or about 9.09 percent[9]. Cayenne pepper is cultivated in many areas of Indonesia and ASEAN countries and grows in the highlands of Mexico, the midlands and lowlands of the Amazon[10]. Cayenne pepper plants can also be found in Peru[11], while in Indonesia, especially East Java, cayenne pepper plants are grown from the lowlands to the highlands[12]. Several previous research results revealed the existence of chili plants at various altitudes, but there is no research explaining the relationship between production risk and price with the environment where the cayenne pepper is grown at various altitudes, so the location with the least risk of cultivating the chili plant can be recommended. Specifically, this study analyzes

cayenne pepper production and price risks in the highlands, midlands, and lowlands, the behavior of farmers in the face of the risks of growing cayenne pepper, and the effect of risk at the different altitudes, where cayenne pepper is grown, the season, and use of production inputs on the productivity and income from the cayenne pepper crop.

2 Materials and Methods

2.1 Study Subjects

This research was carried out in Lombok, West Nusa Tenggara province. The subject of the research was the cultivation of cayenne pepper for the 2020/2021 growing season in the rainy season and the 2021 planting season in the dry season. The rainy planting season in Indonesia lasts from November to April, while the dry planting season is from May to October[13,14].

2.2 Study Design

This research was an explanatory study[15], an investigation that explained and related one variable to another that was different in society but was interrelated and produced a cause-effect relationship. The research location was determined by purposive sampling at various stages, starting at the district, sub-district, and village level[16]. The investigation was conducted in the area of the cayenne pepper production centers. Research sited in Timbanuh village, Pringgasela district represent highland areas (> 500 mpl), in Suralaga district of Kerongkong village represent medium lands (200–500 mpl), and in Labuhan Haji district from Labuhan Haji village represent lowland areas (< 200 mpl).

2.3 Participants

The participants in this study were farmers who grew cayenne pepper plants in the location where the research was conducted. The number of participants in this study was 15 farmers from each selected village, so all participants were 45 farmers. Three key informants were assigned to each village, namely agricultural field extensionists, collectors and distributors of agricultural production facilities, bringing the total to nine people.

2.4 Data Collection

Data collection using structured interview methods with questionnaires, in-depth interviews with key informants, field observations, virtual survey, literature review, documentation, and secondary data collection. The respondents in the structured interview were farmers who grow chili plants in the research villages. As key informants in the in-depth interviews were agricultural extension agents, collectors and distributors of agricultural production establishments.

2.5 Data Analysis

The productivity and income of cayenne pepper cultivation at various altitudes (highlands, mid-plains, and lowlands) were analyzed using the following formula:

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

$$\prod j = \sum_{k=1}^{m} Pk \; x \; Q_k - TC \quad (2)$$

$$TC = VC + FC \quad (3)$$

where:
Q - cayenne pepper production (kg/ha);
Y - cayenne pepper crop income (IDR 000);
P - cayenne pepper price (IDR/kg);
TC - total cost (IDR 000);
VC - variable cost (IDR 000);
FC - fixed costs (IDR 000);
J - land level j^{th};
m - number of harvest times;
k – harvest k^{th} (k =1,2,3,……m).

The measurement of agricultural risk, both production risk and price risk, used the variance, the standard deviation and the coefficient of variation[17]. Production and price changes as measures of production and price risks were based on the experience of farmers engaged in previous farming activities[18].

$$\mu_i = q_{ih} Q_{ih} + q_{ir} Q_{ir} + q_{in} Q_{in} \quad (4)$$

$$\sigma_i^2 = q_{ih} [Q_{ih} - {}_i]^2 + q_{ir} [Q_{ir} - {}_i]^2 + q_{in} [Q_{in} - {}_i]^2 \quad (5)$$

$$\theta_i = q_{ih} P_{ih} + q_{ir} P_{ir} + q_{in} P_{in} \quad (6)$$

$$\varphi_i^2 = q_{ih} [P_{ih} - {}_i]^2 + q_{ir} [P_{ir} - {}_i]^2 + q_{in} [P_{in} - {}_i]^2 \quad (7)$$

where:
Q - cayenne pepper production (kg/Ha);
μ_i - cayenne pepper production expectations (kg);
σ_i^2 - variants or risks in cayenne pepper production;
P - cayenne pepper price (IDR/kg);
θ_i - expected price of cayenne pepper (IDR/kg);
φ_i^2 - cayenne pepper variant or price risk;
i - sample i^{th};
q - cayenne pepper production opportunity or price opportunity (%);
h,r,n - high probability (h), normal probability (r) and low (n) probabilities.

Additionally, analyze the level of agricultural risk in each area (mountains, medians and low) using the coefficient of variation[19], with the formula:

$$CVqj = \frac{j}{\underline{Qj}} \quad (8)$$

$$CVpj = \frac{j}{\underline{Pj}} \quad (9)$$

where:
CVqj - production variation coefficient;

σ_i - production standard deviation;
CVpj - the coefficient of variation in the price of cayenne pepper;
Θ_j - standard deviation of the prices;
j - j-normal (1 - high, 2 - medium, and 3 - low).

If the coefficient of variation CVqj or CVpj was greater than 0.5, the production risk or the price risk was in the high category; but if it was less than or equal to 0.5, it was included in the low-risk category[19].

To analyze the behavior of farmers against the risk of agriculture using the basic model proposed by [20]. The data analysis used an econometric approach and the following model of multiple regression equations:

$$Ni = a_0 + a_1 i + a_2 i^2 + a_3 i_, + a_4 i^2 + a_5 W_{Ti} + a_6 Px i_+ a\,7_p qi_+ E_1 \quad (10)$$

$$Ti = b_0 + b\,1_{i+} b_2 i^2 + b\,3_{i,+} b\,4_{i\,2}{}^+ b_5 W_{Ti} + b_6 Px_i + b_7 P_{qi} + E_2 \quad (11)$$

$$Xi = c_0 + c_{1\,i} + c_{2\,i}{}^2 + c\,3_{i,+} c\,4_{i\,2}{}^+ c_5 W_{Ti} + c_6 Px\,i + c_7 Pq_i + E_3 \quad (12)$$

where:
Ni - cayenne pepper planting area (ares);
Ti - total labor usage (HKO);
Xi - production inputs other than labor and land (IDR000);
W_T - labor wages (IDR000/HKO);
P_X - important entry price level (IDR000/unit);
Pq - cayenne pepper product price (IDR000/ares);
Ei - error (interference).

If production risk (ϕ_i^2) or price risk (σ_i^2) had a positive and significant effect on the confidence level of at least 75% in the use of production inputs (Ni, Ti or Xi), meant that farmers behave bravely toward agricultural risks (*risk takers*); and if it had a negative effect, farmers behave in fear of agricultural risk (*risk aversion*); but if the effect was positive or negative but not significant on the level of confidence, then the role was neutral toward risk *(risk neutral).*

To analyze the relationship and influence of crop risk, altitude, season and the use of production inputs on the production (Q) and income of the cayenne pepper crop (Y), the following regression analysis was used:

$$Q_i = d_0 + d_1 N_i + d_2 T_i + d_3 X_i + d_4 i^2 + d_5 i^2 + d_6 D1_{ij} + d_7 D2_{ij} + d_8 D3_{ij} + E4... \quad (13)$$

$$Y_i = e_0 + e_1 N_i + e_2 T_i + e_3 X_i + e_4 i^2 + e_5 i^2 + e_6 D1_{ij} + e_7 D2_{ij} + e_7 D3_{ij} + E5... \quad (14)$$

where:
D1 - dummy variable (D1 = 1 if the terrain is medium, and D1 = 0 if the other terrain;
D2 - dummy variable (D2 = 1 if highlands, and D2 = 0 if other plateaus);
D3 - dummy variable (D3 = 1 in the dry season and D3 = 0 in the rainy season).

3 Results and Discussion

3.1 Demographic Characteristics

Characteristics of cayenne pepper growers were described from the characteristics of respondents in cayenne pepper production centers located in the highlands, mid-plains, and lowlands. Characteristics in question include age, education level, number of household members, cayenne pepper growing experience, main job, side job, cayenne pepper growing area.

Tab. 1 Characteristics of cayenne pepper farmers based on altitude (Processed primary data, 2021)

No.	Age (Year)	Highlands		Mediumlands		Lowlands		Aggregate	
		people	%	People	%	People	%	People	%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A. Age of farmer (years)									
1.	20 - 30	1	6.67	0	0	0	0	1	2.22
2.	31 - 40	7	46.67	2	13.33	3	20.00	12	26.67
3.	41 - 50	6	40.00	10	66.67	8	53.33	24	53.33
4.	51 - 60	1	6.67	2	13.33	2	13.33	5	11.11
5.	≥61	0	0	1	6.67	2	13.33	3	6.67
B. Farmer education									
1.	TS	3	20.00	0	0	0	0	3	6.67
2.	PS	12	80.00	4	26.67	8	53.33	24	53.33
3.	SS	0	0	7	46.67	4	26.67	7	24.44
4.	HS	0	0	3	20.00	3	20.00	6	13.33
5.	PT	0	0	one	6.67	0	0	one	2.22
C. Experience in Cayenne Pepper Cultivation (Years)									
1.	≤5	7	46.67	2	13.33	2	13.33	11	24.44
2.	6–10	8	53.33	2	13.33	5	33.33	15	33.33
3.	11–15	0	0	2	13.33	3	20.00	5	11.11
4.	16–20	0	0	6	40.00	4	26.67	10	22.22
5.	>20	0	0	3	20.00	1	6.67	4	8.89
D. Members of the farmer's household (persons)									
1.	<3	0	0	1	6.67	1	6.67	2	4.44
2.	3–4	13	86.67	13	86.67	13	86.67	39	86.67

Continuation of Tab. 1									
3.	> 4	2	13.33	1	6.67	1	6.67	4	8.89
E. Cayenne Pepper Planting Area (ha)									
1.	≤ 0,10	2	13.33	2	13.33	5	33.33	9	20.00
2.	0.11–0.20	6	40.00	5	33.33	7	46.67	18	40.00
3.	0.21–0.30	4	26.67	4	26.67	1	6.67	9	20.00
4.	0.31–0.40	0	0	2	13.33	1	6.67	3	6.67
5.	0.41- 0.50	3	20.00	2	13.33	1	6.67	6	13.33
F. Farmer's main job									
1.	Farmer	15	100.00	13	86.67	14	93.33	42	93.33
2.	Merchant	0	0	0	0	1	6.67	1	2.22
3.	Teacher	0	0	1	6.67	0	0	1	2.22
4.	Other	0	0	1	6.67	0	0	1	2.22
G. Secondary work of the farmer									
1.	Farmer	0	0	2	13.33	1	6.67	3	6.67
2.	Merchant	0	0	1	6.67	0	0	1	2.22
3.	Service/Work	0	0	3	20.00	1	6.67	4	8.89
4.	None	15	100.00	9	60.00	13	86.67	37	82.22
Number of farmers		15	100.00	15	100.00	15	100.00	45	100.00

Notes: TS - no primary school; PS - primary school; SS - secondary school; HS - high school; PT - university

Based on Tab. 1, the characteristics of cayenne pepper farming households as a function of altitude above sea level were slightly different between farming households in the highlands and farming households living in the lowlands, middle, and lowlands, but between farm households in the middle and lowlands they were relatively equal. The age of farmers living in the highlands was relatively young, between 20 and 30 years, but it was not found to exceed 60 years. Likewise, their experience in the cultivation of cayenne pepper, all of them were less than 10 years old and half of them were less than 5 years old; while farmers living in the middle and lowlands were half of the farmers with more than 10 years of experience. The same followed from the level of formal education that has been taken; peasants living in the mountains, education was relatively low up to primary school (SD) even 20% of them had never received formal education; they all had a main job as a farmer. Unlike the farmers in the middle and lowlands, some of them were educated up to university (PT), some had jobs outside of agriculture; it meant working as a farmer only as a side job. However, in general, cayenne pepper acreage averages less than 0.50 acres.

Based on the above characteristics of the farming households, it can be concluded that farmers living and growing cayenne pepper in the highlands were relatively younger, less educated, less experienced, and worked more homogeneously than farmers in the highlands, who lived in the medium and lowlands. However, judging by the number of household members and the cayenne pepper area, they were relatively equal in all three locations.

3.2 Productivity and Agricultural Income of Cayenne Pepper

Farmers who grew cayenne pepper were supposed to seek maximum income or profit. To achieve this objective depends on the production, price, and costs.

3.2.1 Production and Price of Cayenne Pepper

Yield was the total yield of cayenne pepper until the cayenne pepper plant was unable to produce. The duration and intensity of the cayenne pepper crop in the rainy season and the dry season for the planting year 2020/2021 were 12 times each. However, production in the rainy season was lower, with an average of 7,552 kg/ha; while in the dry season the average was 11,247 kg/ha. However, the average price received during the rainy season was IDR 19,785/kg; while during the dry season was Rs 16,357/kg. The price of cayenne pepper between the highlands, medium lands, and lowlands in the same season did not vary much, i.e., in the rainy season it ranged between IDR 19,386 and IDR 20,452 per kilogram; and in the dry season it ranged between IDR 16,213 and IDR 16,491 per kilogram (Tab. 2).

Tab. 2 Production and average price of cayenne pepper in the rainy and dry seasons according to altitude (Processed primary data, 2021)

No.	Harvest time	Highlands (24 ares)		Medium lands (23 ares)		Lowlands (18 ares)		Aggregate (22 ares)	
		Production (kg)	Price (IDR/kg)	Production (kg)	Price (IDR/kg)	Production (kg)	Price (IDR/kg)	Production (Kg)	Price (IDR/kg)
	A. Rainy season								
1.	Harvest 1	26.87	16,100	66.00	15,933	38.33	15,567	43.73	15,767

Continuation of Tab. 2

2.	Harvest 2	52.67	35,467	110.33	35,467	79.00	35,000	80.67	35,280
3.	Harvest 3	82.80	30,267	168.00	30,267	115.73	30,800	122.18	30350
4.	Harvest 4	116.00	25,133	226.00	25,333	167.00	25,067	169.67	25,206
5.	Harvest 5	148.33	21,100	306.00	18,033	222.33	20,600	225.55	19,874
6.	Harvest 6	183.67	18,033	248.00	20,533	276.00	18,167	235.89	18,849
7.	Harvest 7	151.33	15,867	198.00	15,867	220.67	15,733	190.00	15,758
8.	Harvest 8	119.67	14,800	149.00	14,767	163.93	14,733	144.20	14,758
9.	Harvest 9	87.67	15,367	110.00	15,000	116.67	15,600	104.89	15,324
10	Harvest 10	59.33	12,667	73.33	13,000	81.00	12,600	71.22	12,709
11	Harvest 11	35.33	12,667	42.33	12,667	51.33	13,167	43.00	12,721
12	Harvest 12	20.33	11,033	19.20	11,033	27.87	11,233	22.47	11,019
Total (kg/LLG)		1,084.33	19,386	1,716.20	20,452	1559.87	19,518	1,453.46	19,785
Average (kg/Ha)		5042.10	19,386	7,804.23	20,452	9,808.93	19,518	7,551.75	19,785
B. Dry Season		(22 ares)		(21 ares)		(16 ares)		(20 ares)	
1.	Harvest 1	33.67	12,000	61.00	12,000	49.33	12,000	48.00	12,000
2.	Harvest 2	65.60	13,200	117.00	13,333	94.40	13,000	92.33	13,134
3.	Harvest 3	142.53	15,000	192.67	15,367	145.00	15,867	160.07	15,362
4.	Harvest 4	204.00	16,000	278.33	15,733	208.00	16,000	230.11	15,865
5.	Harvest 5	285.33	18,533	378.33	18,000	278.33	18,000	314.00	18,181
6.	Harvest 6	369.40	18,000	484.40	18,000	351.67	17,167	401.82	17,744
7.	Harvest 7	277.00	20,000	397.33	20,300	281.33	21,340	318.55	20,546
8.	Harvest 8	197.00	15,500	299.33	15,400	218.67	15,000	238.33	15,280
9.	Harvest 9	129.53	11,000	190.33	11,000	161.33	11,000	160.40	11,000
10	Harvest 10	75.07	13,000	105.53	13,000	90.67	12,000	90.42	12,667
11	Harvest 11	44.00	13,000	55.33	13,333	51.40	14,000	50.24	13,470
12	Harvest 12	21.60	10,500	25.73	10,000	23.93	11,000	23.75	10,500
Total (kg/LLG)		1,882	16,491	2,585	16,368	1,954	16,213	2,128.03	16,357
Average (kg/ha)		8,306	16,491	12,750	16,368	12,456	16,213	11,246.70	16,357

If you compared the price of cayenne pepper in 2020/2021 with the prices of previous years, it seemed that the price of cayenne pepper was getting higher and more stable. For example, in 2018/2019, the price of cayenne pepper on the island of Lombok in the wet season averaged IDR 15,153/kg and in the dry season averaged IDR 8,620/kg[7].

3.2.2 Cayenne Pepper Growing Costs

The costs of growing cayenne pepper differed between the highlands, medium lands, and lowlands; but between the mediumlands and the lowlands, they were relatively equal. Likewise, the costs between the rainy and dry seasons in each plain were relatively equal (Tab. 3).

Tab. 3 Average cost of cayenne pepper cultivation (IDR x 000/ha) during the rainy and dry seasons according to altitude (Processed primary data, 2021)

No.	Rate Type	Highlands		Medium lands		Lowlands		Aggregate	
		Rainy seasons	Dry seasons	Rainy seasons	Dry seasons	Rainy seasons	Dry seasons	Rainy seasons	Dry seasons
A. Variable cost		32,224	41,355	81,462	102,472	83,593	101,755	65,766	81,861
1.	Material	8,853	13,075	15,902	16650.	13,158	17,947	12,638	15,891
2.	Workforce	11,138	15,832	44,887	64,403	50,763	65,024	35,596	48,420
3.	Other Var Fee	12,252	12,448	20,673	21,419	19,672	18,784	17,533	17,550
B. Fixed cost		9,459	9,460	13,955	12,166	12,897	9,648	12,103	10,425
1	Land lease	8,807	8,398	12,657	10,663	11,723	8,344	11,062	9,135
2	Land tax	240	249	308	338	302	305	283	297
3	Water rate	0	390	229	376	205	307	145	358
4	Contraction	412	422	761	790	668	692	613	635
Total A + B		41,702	50,814	95,417	114,638	96,490	111,404	77,870	92,285

The cost of growing cayenne pepper in the highlands was less than 50% of the costs incurred by medium land and lowland farmers in both the wet and dry seasons. In the rainy season and dry season, the average cost of cayenne pepper cultivation in the highlands was Rs 41.7 million

per hectare and Rs 50.8 million per hectare, respectively; while in the middle plains it was 95.4 million and 114.6 million/ha and in the lowlands it was 96.5 million and 111.40 million rupees/ha (Tab. 3).

3.2.3 Income and Efficiency of Cayenne Pepper Cultivation

Farming was said to be profitable if the amount of income earned was greater than the costs incurred or the value of the RC ratio was greater than one. The income from cayenne pepper cultivation in Lombok Island in 2020/2021, when calculated per hectare, was considered quite high, i.e., in the rainy season it averages about Rs 71 million per hectare and in the dry season, it reached about 92 million rupees per hectare. The cultivation of cayenne pepper on the island of Lombok, both in the rainy and dry seasons, was considered profitable because the R/C ratio was greater than 1 (one) (Tab. 4).

Tab. 4 Average production, prices, production value, production costs and agricultural income of cayenne pepper (IDR000/Ha) in the rainy and dry seasons by altitude (Analysis of primary data, 2021)

No.	Description	Highlands		Middle lands		Lowlands		Aggregate	
		Rainy seasion	Dry season	Rainy seasion	Dry season	Rainy seasion	Dry season	Rainy seasion	Dry season
1	Production (kg/ha)	5,042	8,534	7,804	12,750	9,809	12,456	7,552	11,247
2	Price (USD/kg)	19,386	16,491	20,452	16,368	19,518	16,213	19,785	16,357
3	Production value (IDR000)	97,746	140,735	159,612	208,699	191,451	201,944	149,603	183,792
4	Production cost (IDR000)	41,702	50,814	95,417	114,638	96,490	111,404	77,870	92,285
5	Farming Income (IDR000)	56,044	89,921	64,195	94,061	94,961	90540	71,733	91,507
6	R/C ratio	2.34	2.77	1.67	1.82	1.98	1.81	2.00	2.13

3.2.4 Cayenne Pepper Production Risks

The production risk was analyzed using the production variance measured by adding the difference in the square of the production with the production expectations multiplied by the probability of each event (high, normal and low production) based on their experience in the activitiescayenne pepper cultivation. Additionally, from the variance value obtained, the standard deviation and the coefficient of variation were calculated to determine the level of risk faced by farmers.

Based on the results of the analysis, it was known that the highest production risk was faced by highland farmers with a coefficient of variation of 0.46, followed by medium lands farmers 0.42, and the lowest is faced by lowland farmers 0.34. But in general, the production risk faced by cayenne pepper growers in Lombok Island was relatively low, the value of the coefficient of variation was still below 0.5 (Tab. 5).

Tab. 5 Expectations and risks of agricultural production of cayenne pepper depending on altitude (Analysis of primary data, 2021)

No.	Description	Highlands	Medium lands	Lowlands	Aggregate
1	Agricultural Experience (years)	10	29	26	22
2	Possibility of Production (kg/Ha)				
	● High production	10,421	14,985	15,136	13,514
	● Normal production	6,744	10,185	10,906	9,278
	● Low production	2,749	4,153	5,243	4048
3	Production Experience (MT)				
	● High production	2	7	6	5
	● Normal production	5	14	13	11
	● Low production	3	8	7	6
4	Production opportunity (portion)				
	● High production	0.21	0.24	0.22	0.23
	● Normal production	0.46	0.48	0.52	0.49
	● Low production	0.32	0.27	0.26	0.28
5	Production Expectations (kg/ha)	6,220	9,658	10,371	8,787
6	Production Variation				
	● High production	17,645,701	28,381,404	22,704,589	22,348,221
	● Normal production	274,183	8,489,233	521,068	241,764
	● Low production	12,051,230	30,298,760	26,299,068	22,451,932
7	Production Risk				
	● Production variation (ι^2)	8,256,362	16,356,598	12,259,434	11,390,835
	● Production Standard Deviation ($_i$)	2,873	4044	3,501	3,375

	● Production Variation Coefficient (CV_q)	0.46	0.42	0.34	0.38
8.	Upper Yield Lower Limit (kg/ha)	474	1,569	3,368	2,037

In addition to having a low production risk, the cayenne pepper crop on Lombok Island had a positive lower outperformance value (Lq > 0). This indicated that the cayenne pepper crop on the island of Lombok will not suffer from a production viewpoint.

3.2.5 Cayenne Pepper Price Risk

The price risk was also measured in the same way as the production risk calculation. The results of the analysis showed that the coefficient of variation in the price of cayenne pepper between altitudes on the island of Lombok was relatively the same, specifically in the highlands 0.62; in the mediumland 0.63 and in the low lands 0.61. All the lands had a coefficient of variation of prices greater than 0.5 (Tab. 6), which meant that the rice risk faced by cayenne pepper growers on the island of Lombok was high.

Tab. 6 Cayenne pepper price expectations and risks on the island of Lombok based on altitude (Analysis of primary data, 2021)

No.	Description	Highlands	Medium lands	Lowlands	Aggregate
1	Agricultural experience (years)	10	29	26	22
2	Possible Price (IDR/kg)				
	● High price	33,333	34,667	33,333	33,778
	● Normal price	15,967	15,633	15,700	15,767
	● Low price	4,233	4500	4,367	4,367
3	Commercial experience (years)				
	● High price	2	7	6	5
	● Normal price	5	15	13	11
	● Low price	3	7	7	6
4	Price Opportunity (Portions)				
	● High price	0.22	0.24	0.22	0.23
	● Normal price	0.50	0.52	0.52	0.52
	● Low price	0.27	0.25	0.26	0.26
5	Price expectation (IDR/kg)	16,494	17,336	16,656	16,837
6	Price variants				
	● High price	283,571,114	300,348,600	278,140,650	286,984,046
	● Normal price	277,831	2,899,409	913,523	1,145,987
	● Low price	150,318,146	164.765420	151,022,406	155,513,561
7	Price risk				
	● Price variation (ι^2)	103,073,876	113,086,843	101,177,097	105646154.6
	● Price Standard Deviation ($_i$)	10,153	10,634	10,059	10,278
	● Coefficient (CVp)	0.62	0.61	0.60	0.61
8	Higher performance lower bound	(3,811)	(3,932)	(3,462)	(3,720)

In addition to having a high price risk, the cayenne pepper crop on the island of Lombok had a lower maximum yield value of a negative price (Lp < 0). These two indicators gave a signal to farmers to be more careful because they were always shadowed by the possibility of loss because of risk or fluctuations in the price of cayenne pepper.

3.3 Behavior of Farmers against the Risks of Growing Cayenne Pepper

The results of the multiple linear regression analysis showed that production risk, price risk together with other independent variables (F test) affected the behavior of farming households in the use of the abovementioned various production inputs. The results of the partial analysis (t-test) showed that the production risk (ι^2) and the price risk (i_2) hada positive effect on the use of the previous production inputs, although not all of them had a positive effect. This further proved that cayenne pepper farmers on the island of Lombok behave boldly (*risk takers*) despite production and price risks or at least neutrally (*counter-neutral risk* versus agricultural risk). This meant that farmers' awareness of the existence of these two agricultural risks had encouraged farmers to overcome them by using more and more production inputs, so that their crop did not fail.

Tab. 7 Results of the estimation of the behavior of the farmers against the risks of the cultivation of cayenne pepper on the island of Lombok, 2020/2021

No.	Independent variable	Dependent variable and regression coefficient of the independent variable				
		Planting area (Ni)	Workforce (Ti)	Organic Fertilizer ($_{XO}$)	Fertilizer An Organic ($_{XA}$)	Plastic mulch ($_{XM}$)
1	Constant	5.20000	97.80000	601,000	519,000	0.400000
2	Production expectations (θ_i)	0.00671 [a]	0.02610a [–]	0.19300a [–]	0.138000 [a]	0.016900 [a]
3	Production Risk ($_i^2$)	0.000003 [a]	0.000114 [a]	0.00074 [to]	0.000161	0.000083 [a]
4	Price expectation (ι)	[-] 0.00159b	[-] 0.007060a	[-] 0.09574a	[-] 0.05370a	[-] 0.00430b
5	Price risk (ι^2)	0.000047	0.0001880	0.00342 [a]	0.002970 [a]	0.000124
6	Labor wages (P_T)	[-] 0.00011a	0.0003670 [a]	[-] 0.00301a	- 0.00009 [to]	[-] 0.00018a
7	Price of an Org Fertilizer (P_x)	- 0.00229	- 0.0245000	0.062000	- 0.041000	- 0.005600
8	Starting price (Pq)	0.001970 [a]	0.0042800	0.038700	0.018400 [a]	0.005540 [a]
	F-account	3:16 [p.m.]	10:39 [p.m.]	14:00 [–]	5.70 [a.m.]	15.91 [to]
	Coefficient Determination (%)	56.40	65,600	54.40	32.70	57.60
	Durbin–Watson statistics	2.17761	1.96915	1.99925	1.64757	2.10535

Notes: Significant at alpha < 1%; Significant at alpha < 5%; Significant at alpha < 10%

3.4 Effect of Crop Risk, Altitude, Season and the Use of Production Inputs in the Cultivation of Cayenne Pepper

In this study, the factors believed to affect farm production and income were other than the use of production inputs, as well as farm risk, altitude and season. The results of the multiple regression analysis indicated that these factors together affected the production and income of the cayenne pepper crop with a confidence level of greater than 99% or a significance level of one percent. These factors also contributed 94.70% and 85.10% to the variations in the production and income of the cayenne crop (Tab. 8).

Tab. 8 Results of the estimation of the effect of agricultural risk, altitude, season and production inputs on the production of cayenne pepper and agricultural income

No.	Independent variable	Dependent variable	
		Production (kg) (Q)	Income Faming (IDR000) (Y)
1	Constant	-302,900	2624.0
2	Land Area (Ni) (Are)	29,640 [to]	34,100
3	Labor number (T)	7.9870 [to]	52,160 to
4	Seeds (X_B) (phn)	- 0.04688	- 1.1837 to
5	Fertilizer Urea/ZA(X_{UZ}) (kg)	1.5924 [a]	17,761 to
6	Fertilizer SP36 ($_{XSP}$)	2.6480 [a]	30,760 a
7	Phonska Fertilizer ($_{XPH}$)	- 2.0449 [a]	- 17,094 to
8	Organic Fertilizer (X_{PO})	0.02180	- 0.9990
9	Plastic Mulch (X_{MP})	2.9000	75,370
10	Pesticide ($_{XOB}$)	0.68870a [–]	14,810 a
11	Production Risk (i^2)	- 0.000593 [to]	- 0.00083
12	Price risk (ι^2)	0.001616	0.01425
13	Medium smooth (D1)	42.00	- 3724 a
14	Lowlands (D2)	215.80 [to]	- 1349
15	Planting season (D3)	417.50 [to]	629
	F-account		Significant at alpha < 1%
	Determination coefficient (%)		Significant at alpha < 5%
	Durbin–Watson statistics		Significant at alpha < 10%

Partially, the above factors had positive and negative effects and some had the expected or suspected effect and others were not expected or suspected. The factors that had a positive effect or increase the production and income of the cayenne pepper crop on the island of Lombok were land use (N), labor use (T), use of Urea and ZA fertilizers (X_{UZ}), use of SP36 fertilizer (X_{SP}), and use of medicines (X_{OB}). These factors had a positive and significant effect on increasing agricultural production and income. In contrast to the use of phonska, seeds and fertilizers had a negative and significant effect at a significant level of less than 5%. This showed that the application of these two factors was excessive, so to increase the production and/or income from the cultivation of cayenne pepper was to reduce its use to the optimum limit.

Production risk (ι^2) and price risk (ι^2) had different effects on farm production and income. Production risk had a significant negative effect on cayenne pepper production, but did not have a significant negative effect on farm income. This meant that the more varied the farmers' production was (production risk), especially between the rainy and dry seasons, the average production tended to be lower.

In contrast to the effect of price risk (i^2), this

factor showed a positive influence that was not significant. Although the results of the analysis were not conclusive, the positive influence of this factor on the production and income of the farms indicated that the variation or risk of prices that farmers face each year has taught them to continue fighting to overcome them according to their beliefs; and the results showed that there was a tendency, to higher price risk, higher production and agricultural income obtained.

The altitude above sea level as a place of cultivation of the cayenne pepper that was analyzed as a dummy variable showed that the production of cayenne in the lowlands showed a positive and significant difference with other plains; but in the aspect of agrarian income it did not show a significant difference. Unlike the medium lands, it actually showed a significant negative difference in the aspect of agricultural income, but in production it did not show a significant difference. While the planting season factor showed a significant difference from the production aspect, this was not the case in terms of farm income. From the results of this analysis, it appeared that altitude and season had more influence on production than on farm income.

4 Discussion

The preliminary investigation carried out was related to the existence of risk in the cultivation of cayenne pepper[7]. Using time series data over the period 2002–2012, this study concluded that the volatility (fluctuation) of the price of cayenne pepper on the island of Lombok was increasing over time, even in the period 2002–2012. Volatility exceeded twice the standard deviation. This implies that the cultivation of cayenne pepper on the island of Lombok had a high risk of cultivation.

Meanwhile, the results of the research conducted by Sidik et al.[7] using cross-sectional data in the area of cayenne pepper production centers in East Lombok Regency indicated that the production risk was not high (CV < 0.5) because farmers had experience and were used to working with cayenne pepper in the rainy and dry seasons, while the price risk was high (CV > 0.5) because the price could not be controlled by farmers, but was determined by volatile market prices. Price and production risk levels on Lombok Island were higher than in Kediri East Java with CV of chili price being 0.32 and the CV of chili production being 0.05[26]. Research in the area of cayenne pepper production centers also found that farmers' behavior in facing production risks falled into the category of risk taker, which is indicated by their courage to rent land and invest using expensive production facilities. Meanwhile, faced with price risk, cayenne pepper farmers were risk neutral, meaning that price fluctuations did not affect the use of resources or production inputs.

Agricultural risk was measured by various approaches, most of which were based on the value of the variance, the standard deviation Y coefficient of variation[17]. The three measures were related to each other, where the value of the variance was a determinant of other measures. For example, the standard deviation was the square root of the variance, while the coefficient of variation was the ratio of the standard deviation to the expected value.

Ellis[8] said that small farmers were generally afraid of risk (risk aversion), because the lack of agricultural activities threatens the economic life of their household members. This was confirmed by the results of Fariyani's research[22] in potato and cabbage-producing households, but was different from the results of this study. Siti Rahmania Fajri and Elys Fauziyah[23] showed no significant relationship between efficiency and risk behavior, which meant that agricultural risk did not affect farmers in rice cultivation. Meanwhile, the research results of Jawal Anwarudin[23] showed that the behavior of the large red chili producers toward prices was that they dare to avoid risk. Likewise, the results of the research by Siddik et al.[7] on the cultivation of Virginia tobacco on the island of Lombok showed the behavior of farmers who dared to face agricultural risks, especially in making decisions about production and the use of labor. [24] researching tobacco farmer households in North Carolina, USA, showed that production risk did not have a significant positive effect on acreage, while price risk did not have a significant positive effect, significant negative. The positive effect of production risk was not expected because the US government had put in place various incentives to limit or stop tobacco cultivation in their country.

Risk aversion strategies to control risk were diversification in agriculture, such as mixed cropping[8], and diversification of income sources[24]. Other policies that could respond to natural uncertainties include irrigation, crop insurance, using seed varieties that were resistant to plant pests, diseases, and dry season, and yield stability. Meanwhile, policies to address price uncertainty include price stability, market information, and credit. In relation to price risk, researchers were advised to apply a hybrid wavelet transform model, namely Wavelet-ARIMA and Wavelet-ES, by applying data

representing weekly price rates to obtain the best value, predicting this indicator[25] and considering that the trading volume was critical to estimate the price risk of price patterns accurately[26].

5 Conclusions and Recommendations

5.1 Conclusions

1. Cayenne pepper productivity on the Lombok Island averaged 9,400 kg/ha; the largest occurred in the lowlands (11,133 kg); in the medium lands - 10,277 kg; the lowest was in the highlands (6,674 kg). The agricultural income obtained was an average of 81.6 million IDR/ha; the highest was also in the lowlands at 92.8 crores, then the medium lands at 79.1 crores and in the highlands at 73.0 crores.

2. The risk of cayenne pepper production on the Lombok Island was low with an average coefficient of variation of 0.38; the highest in the highlands 0.46, the medium lands 0.42 and the lowest in the lowlands 0.34. For its part, price risk was classified as high with a coefficient of variation of 0.61 and relatively evenly distributed across locations, namely highlands 0.62, medium lands 0.61, and lowlands 0.60.

3. Farmers' behavior in the face of commercial risks was classified as risk takers, demonstrated by their courage to increase the use of land surface, labor, organic and inorganic fertilizers, and plastic mulch with the growing risks of agriculture they face.

4. The use of inputs for the production of the land, labor, Urea or Za fertilizer, SP36 fertilizer and pesticide had a partial positive effect on the production and income of the cayenne pepper crop, while seeds and drugs had a negative effect. Production risk, altitude, and growing season all affected production, but tended not to affect income from growing cayenne pepper. Farmers' ability to manage production risk affected farm production and income.

5.2 Recommendations

1. It was necessary to conduct research followed by assistance to farmers regarding the optimal use of each input and the right time of planting at each altitude so that farmers avoid the risk of loss and obtain maximum profit.

2. The government also needs to initiate and facilitate partnerships between farmers and companies that produce and distribute cayenne pepper products, as well as insurance companies to increase farmers' enthusiasm for growing cayenne pepper, so that the annual inflation contributed by this basic product will decrease and the well-being of farmers will be guaranteed.

Acknowledgment

Many thanks to the Rector, Director of the Community Service and Research Institute, Dean of the Faculty of Agriculture, University of Mataram, who had provided the budget for the research and publication.

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