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Risk Level in Broiler Production in Jordan Industry

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Abstract: This study was conducted to determine the risk level in broiler industry in Jordan. Production risk is the random variability inherent in a farm's production process. Weather severities during seasons lead to production risk in most livestock activities. Broiler production is not an exception. North, Middle and South broiler production regions in Jordan were investigated. To determine the level of risk according to season of production as source of risk in the 3 regions of broiler production in Jordan the probability distribution, standard deviation, coefficient of variation and the highest lower bound indicators for risk level were used; the indicators were so simple to be fully understood by both the decision makers and the local producers. The broiler producers net income considered to be the core element in explaining the risk effect. The results of the study showed that the northern and the Southern regions of broiler production in the country suffer from high and moderate level of risk, respectively. The middle region is with the lowest level of risk. These results derived from the indicators used in the study, the probability distribution curve of the net income of broiler producers under risk in the northern region is more flattened than the probability distribution curve of the net income of broiler producers under risk in southern region, which in turn more flattened than the one in the middle region. The more flattened curve the more risk level. The standard deviation of the net income values for the northern, middle and southern regions are almost 511, 261 and 424, respectively. The higher SD value the higher level of risk. The Northern region is with the highest SD, which means that this region is with the highest risk level since it is with the highest value of SD. The middle region is with the lowest SD, which means that this region is with the lowest risk level. The Southern region is in the middle of these 2 regions but it is relatively with high level of risk. The CV values are 0.36, 0.13 and 0.31 for the Northern, middle and Southern regions, respectively. These values are another indication of the levels of risk in the three regions. The higher CV the higher level of risk. The values of CV indicates the same results of SD. Regarding the higher lowest bound values, the lower HLB value the higher level of risk. The HLB value in the Northern region is almost 392 and it is 1470 in the middle region and 520 in the southern region. These values indicate that the Northern region is with the highest level of risk since, it is with the lowest HLB value, level of risk in the middle region is the lowest level in the three regions since the HLB value is the highest one. The Southern region is with high risk level but it is lower than that in the Northern region.

Key words: Risk level, net income, broiler production, season, weather, probability distribution, standard deviation, coefficient of variation, highest lower bound

INTRODUCTION

Sources of risk in agriculture include production or yield risk, price or market risk, institutional risk and other types of risk like human or personal risks, asset risk, contracting risk and financial risk (Ray, 1981). Various types of risks can be distinguished. The classification of Hardaker *et al.* (1997), who differentiated between business risks and financial risks, can be used for most agricultural risks. Business risks include production risks, which are related to the unpredictable nature of the weather. These risks affect all kinds of production in agriculture. Broiler production sector is not excluded.

In Jordan, broiler production is a very important sector in animal production in. The total number of broiler production farms in the year 2007 is 1940 with a capacity of >26 million birds in each production cycle; these farms provide about 130000 tons of poultry meat for local

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consumption. Compared to the year 2006, the total number of broiler production farms in the country decreased by almost 5%. This decline is mainly due to weather related issues due to seasonal variations (MoA, 2007). Production risk associated with season of production hazards is part of the business environment in broiler production sector in Jordan; producers forced to make decisions in a risky environment during different seasons in this study, they want to learn about risks, which may largely affect their business, they need to know about the risk level in their business and they need information that will make their decisions simpler. Simple tools to be used as risk level indicators are crucial in this manner. Many complicated risk indicators are available, but the local producer will face a problem of how to deal with these indicators. Most of broiler producers in Jordan are with limited level of education, they can't understand the complicated mathematical procedures to determine risk level in their business. They need simple fully understood means to know about risk level in their area of production. This study considered the problem and used 4 simple risk indicators that aid the producer, as well as, the decision makers to determine risk level in the 3 areas of broiler production in Jordan affected by weather as a source of risk; the indicators include probability distribution, the standard deviation, the coefficient of variation and the highest lower bound.

It is well known that weather variability from season to season is an important production factor in all sectors of agriculture. Unfortunately, this production factor can hardly be controlled. In fact, weather risks are a major source of uncertainty in agriculture. This issue is not only important for farm managers but also for policy makers, since income stabilization in agriculture is frequently considered as a governmental task (Valgren, 1932; Hazell *et al*., 1986; Rejda, 1992).

Weather and climate, according to the season, are some of the biggest production risk factors impacting on poultry production performance and management (Castle *et al*., 1987). Extreme weather and climate events such as severe droughts, floods, or temperature shocks often strongly affect broiler production. Factors such as climate variability and change contribute to the vulnerability of individual broiler farms (Agriculture and Agri-Food Canada, 1999). In Jordan, farmers have been struggling to maintain their income by continuously trying to increase broiler production. Such increased productivity may be associated with increased economic and environmental risk as the farming system becomes more vulnerable to climate variability and climate change which leads to production (or yield) risk and affects the farmers ability to repay debt and to cover essential living costs for their families. But the effects of weather events also matter for rural lending institutions and agri-businesses, as they determine the risk exposure of borrowers and input providers (Benson and Clay, 1998; Guillaumont *et al*., 1999).

Weather risks are correlated within a region. This spatial covariance makes, it difficult for local insurers with limited regional diversification to pool risks and offer affordable insurance coverage. While in principal primary insurers could pass on risks to an international reinsurance market, there is little transfer of such risk from the emerging markets for a number of reasons. The size of weather risk readily available for underwriting is limited and transaction costs are high due to lack of standardization and asymmetric information between insurer and reinsurer (Skees, 2000).

The severity of a risk can be quantitatively assessed by mapping the risk on a risk matrix according to the value of the negativity of the outcome and its probability or frequency of occurrence. Often risk lies in the uncertainty of a numerical quantity's future value. When profits or income are modeled as stochastic variables, the variance or standard deviation is a natural measure of fluctuation (Porthin, 2004).

Jordan: Jordan is a relatively small country situated at the junction of the Levantine and Arabian areas of the Middle East. The country (about 5.7 million populations) is bordered on the north by Syria, to the East by Iraq and by Saudi Arabia on the east and South and to the West is Palestine, while Jordan's only outlet to the sea, the Gulf of Aqaba, is to the south. Jordan occupies an area of approximately 96,188 km^2 including the Dead Sea, making it similar in size to Austria or Portugal. However, Jordan's diverse terrain and landscape. Western Jordan has essentially a Mediterranean climate with a hot, dry summer, a cool, wet winter and 2 short transitional seasons. However, about 75% of the country can be described as having a desert climate with <200 mm of rain annually. Jordan can be divided into 3 main geographic and climatic areas: the Jordan Valley, the Mountain Heights Plateau and the eastern desert, or Badia region. The climate in Jordan is dry in summer with average temperature in the mid -30°C and relatively cold in winter averaging around the 7°C. The western part of the country receives greater precipitation during the winter season from November to March and snowfall in Amman (756 m (2,480 feet) ~ 980 m (3,215 feet) above sea-level) and Western heights of 500 m (1,640 feet). Excluding the rift valley the rest of the country is entirely above 300 m (984 feet) (SL). Table 1 shows the average weather conditions in Jordan.

Table 1: Average weather conditions in Jordan

Months	Average sunlight (h)	Temperature: Average Min.	Temperature: Average Max.	Temperature: Record Min.	Temperature: Record Max.	Discomfort from heat and humidity	Relative humidity am	Relative humidity pm	Average precipitation (mm)	Wet days (+0.25mm)
January	7	4	12	-6	24	-	80	56	69	8
February	7	4	13	-5	29	-	78	52	74	8
March	8	6	16	-3	32	-	57	44	31	4
April	10	9	23	1	39	-	53	34	15	3
May	11	14	28	5	41	Moderate	39	28	5	0.8
June	13	16	31	8	43	Medium	40	28	0	0
July	13	18	32	13	40	Medium	41	30	0	0
August	13	18	32	13	43	Medium	45	30	0	0
September	11	17	31	11	39	Medium	53	31	0	0
October	10	14	27	7	37	Moderate	53	31	5	1
November	8	10	21	2	33	-	66	40	33	4
December	6	6	15	-4	25	-	77	53	46	5

http://www.bbc.co.uk/weather/world/city_guides/results.shtml?tt=TT002510

The livestock sub-sector is one of the main constituents of the agricultural sector, which contributes about 60% of the agricultural output and provides a major source of income to 250,000 people. The contribution of the different sectors of livestock to the agricultural produce is variable. While the poultry sector occupies the highest rank, followed by dairy cattle, the small ruminant sector has a special importance due to its social significance. The production of poultry meat and eggs satisfies the consumption need with periodic surpluses as the productive capacity exceeds the local market need. In 2007, the broiler production sector included 1940 broilers farms.

Table 2: Number of the broiler farms in each area of 3 production areas

Area of production	Governorate	No. farms	Capacity (1000 birds)
North	Irbed	499	4696.180
	Jerash	102	858.500
	Mafraq	238	3961.180
	Ajloun	85	629.500
Middle	Amman	375	6161.900
	Madaba	117	1736.300
	Zarqa	130	2781.757
	Balqaa	137	2056.750
South	Karak	187	2898.015
	Tafeeleh	33	391.800
	Maan	10	35.000
	Aqaba	27	514.190
Total	12	1940	26360.880

MoA (Annual Report, 2007) Jordan

MATERIALS AND METHODS

Data collection: The study covered the whole broiler production areas in the country, all the country governorates were resembled in the sample, the study area were divided into 3 major production regions, Northern, middle and Southern regions of the country (Table 2). The total number of broiler farms in the three regions of production is 1940; from these the sample was chosen.

A questionnaire was constructed to collect the necessary data. Socio-economic related information, total variable costs and net farm income were the main items in the questionnaire; these items were broken down to their corresponding subtitles. The collected data is an average of 4 production cycles for each 10000 birds capacity broiler farm covering a 1 year period (2007). This capacity is the most dominant in the 3 areas of broiler production in Jordan. Each production cycle took place in one season of the 4 seasons during the year. To come up with the necessary data about the risk level the farmers were asked to group the seasons of production according to the following 3 levels of risk: high, medium and low. Sixty six broiler producers in Jordan were interviewed in each of the 3 production regions: Northern, middle and Southern regions. The same producers were interviewed after the end of each season during the year 2007. The risk indicators were applied on the data in the 3 regions.

Sample size: Sixty six producers were interviewed throughout the country every season, the sample size was determined according to the following equation:

$$n = [(p.\ q.\ z^2)/e^2]/[(N.\ e^2) + (z^2.\ p.q)/(N.\ e^2)]$$

where:

- n = Sample size
- p = The proportion that the sample will occur
- q = The proportion that the sample will not occur = (1 - p)
- z = The standardized score
- e = Error term
- N = Population

The sample size was determined at a confidence level of 0.90; this level was an appropriated level due to the reason that the population itself was relatively small in

size. The term error was 0.10 and the Z value correspondent to this level is 1.65, the proportion that the sample will occur was 0.50 and proportion that the sample will not occur was also 0.50 and the population was 1940. The sample size according to the above mentioned equation was 66. The number of the producers to be interviewed in each one of the production areas was determined according to the number of the broiler farms in each area. Table 3 shows the number of producers interviewed in each area of 3 production areas: Additional 24 producers were interviewed for precession and certainty purposes but not included in the statistical analysis. The same producers in each area were interviewed each season.

The indicators: To determine risk level in the 3 areas of broiler production in Jordan, the following 4 simple risk indicators were used:

The probability distribution: A distribution of a variable that expresses the probability that particular attributes or ranges of attributes will be, or have been observed, it identifies the probability of being less than or equal to a particular parameter or value. In this study, the probability distribution is the distribution of values of a specific event over an expected results of this event, the event here is the highest net income to be achieved affected by the severity of the season in which the production process took place. Variation in net income indicated by the flatness or steepness of the shape of the normal distribution of the observations means different levels of risk. A normal distribution of data means that most of the examples in a set of data are close to the average. A normally distributed data (Fig. 1).

The standard deviation: The standard deviation is a statistic that tells us how tightly all the various observations are clustered around the mean in a set of data. When the observations are pretty tightly bunched together and the bell-shaped curve is steep, the standard deviation is small. When the observations are spread apart and the bell curve is relatively flat that tells you have a relatively large standard deviation. The Standard Deviation (SD) quantifies variability. If the data follow a bell-shaped distribution, then 68% of the values lie within one SD of the mean (on either side) and 95% of the values lie within 2 SD of the mean. The standard deviation measures the spread of the data about the mean value. It is useful in comparing sets of data which may have the same mean but a different range. The higher the standard deviation the more dispersion in net income, which

Table 3: Number of producers interviewed in production areas every season

Area of production	Total No. farms	Compared (%) to country farms	Producers to be interviewed
North	924	47.63	31
Middle	759	39.12	26
South	257	13.25	09
Total	1940	100.00	66

Calculated by the researchers

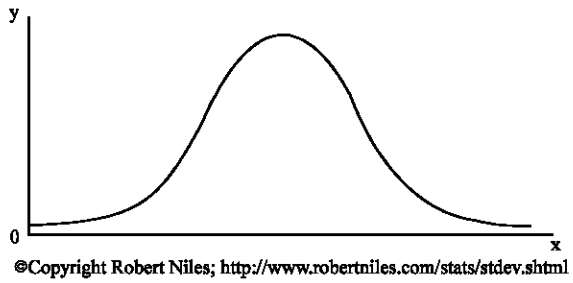

Fig. 1: A normally distributed data

means higher level of risk. The standard deviation is often used by investors to measure the risk of a stock or a stock portfolio.

The standard deviation could be calculated as follows:

$$S^2 = \sum_{i=1} (xi-\bar{x})^2/(n-1)n$$

where:

S^2 = Variance
xi = Net income
$\bar{x}$ = Mean of net income
n = No. producers

Then the standard deviation:

$$SD = \sqrt{S^2}$$

The coefficient of variation: In probability theory and statistics, the Coefficient of Variation (CV) is a normalized measure of dispersion of a probability distribution. It is defined as the ratio of the standard deviation to the mean. It is given as a percentage and is used to compare the consistency or variability of 2 more series. The higher the C V, the higher the variability and the higher the level of risk and lower the CV, the higher is the consistency of the data and the lower the level of risk. The coefficient of variation could be calculated as follows:

$$CV = S/X$$

where:

CV = Coefficient of Variation
S = The standard deviation
X = Mean of net income

The highest lower bound: In analysis the infimum or greatest lower bound of a subset S of real numbers is denoted by inf (S) and is defined to be the biggest real number that is smaller than or equal to every number in S. In this study, this indicator resembles the least net income would be accepted by the producer, under this net income value no value is profitable. The risk level increases as the value of the net income decreases below this value. The highest lower bound could be calculated as follows:

$$L = X - 2S$$

where:

L = Coefficient of variation
S = The standard deviation
X = Mean of net income

Data analysis

The probability distribution: The season in which the production process takes place is very important factor to be considered. In Jordan, production in winter and summer seasons is expected to have the most risky situation during the production process throughout the year, but the collected data about the most risky season that may negatively affect the production process showed that only 0.30 of the interviewed producers in the 3 regions (20 producers of 66) considered these 2 seasons to be with high level of risk, 0.50 of the producers (33 producers of 66) considered production in autumn is with medium level of risk and 0.20 the producers (13 producers of 66) considered production in spring is with low level of risk. According to these circumstances and according to the expected hazards of these seasons, the probability that broiler production to be risky in winter and summer seasons considered to be 0.30, the probability that broiler production to be risky in autumn considered to be 0.50 and the probability that broiler production to be risky in spring considered to be 0.20. Table 4 and 5 show the proposed probability of winter and summer, autumn and spring seasons to be a source of risk on broiler production process in the 3 regions of the study in Jordan. Contrary to the expected high percentage of producers to consider winter and summer to be the highest source of risk, the low percentage of those may be interpreted by the cautioned measures that they adopt in preparing to face the expected hazards of these 2 seasons. Fewer measures adopted in both autumn and spring.

The basic data, to determine the probability that the related season of production considered to be at a certain level of risk, collected upon the following 3 questions:

- Do you consider winter and summer seasons to be with high level of risk?
- Do you consider autumn season to be with medium level of risk?
- Do you consider spring season to be with low level of risk?

The probability of seasons of the year to be a source of risk in broiler production process is very important in determining the effect of the risk source on the net income of the producers; this means that we are taking in consideration the results of the risk on the net income of the producers. Without taking these probabilities in consideration the value of the expected net income under risk is not correctly determined. The average net income of the interviewed producers in the three regions of the study according to the seasons of production was determined both with and without taking the risk factor (season) in consideration. The results shown in Table 6 and 7.

Based on the collected data and to determine the level of risk in the 3 production areas for comparison reasons, the probability distribution for each production area was plotted correlating the average net income of the producers in each region with the probability of the risk to occur in winter and summer, autumn and spring seasons.

The standard deviation, the coefficient of variation and the highest lower bound: For the purposes of confirming the results obtained from the probability distribution

Table 4: Sample distribution in the three areas of production according to the consideration of the seasons to be a source of risk

	Seasons		
Area	Winter and Summer (High risk level)	Autumn (Medium risk level)	Spring (Low risk level)
North	30	28	08
Middle	09	39	18
South	21	32	13
Average	20	33	13

The study survey

Table 5: Probability of seasons of the year to be a source of risk on broiler production process in Jordan

Seasons	Probability of season to be a source of risk
Winter and Summer	0.30 = (20/66)
Autumn	0.50 = (33/66)
Spring	0.20 = (13/66)
Total	1.00 = (66/66)

Proposed by the researchers according to season as a source of risk in Jordan based on Producer's consideration

Table 6: Average net income of the interviewed producers without risk consideration

	Average net Income (JDs)		
Event (seasons)	North	Middle	South
Winter and Summer	935	1520	878
Autumn	1695	1995	1435
Spring	2234	2220	1998

Calculated by the researchers

Table 7: Average net income of the interviewed producers with risk consideration

	Region								
	North			Middle			South		
Event (seasons)	NI (JDs)	P	EI	NI (JDs)	P	EI	NI (JDs)	P	EI
Winter and Summer	935	0.30	280.5	1520	0.30	456.0	878	0.30	263.4
Autumn	1695	0.50	847.5	1995	0.50	997.5	1435	0.50	717.5
Spring	2234	0.20	446.8	2220	0.20	444.0	1998	0.20	399.6

Calculated by the researchers

indicator, the standard deviation, the coefficient of variation and the highest lower bound indicators values were determined. These values are supportive measures for the main indicator, the probability distribution (Mendenhall, 1983).

RESULTS AND DISCUSSION

The probability distribution: Figure 2-4 show the probability distribution for each of the 3 production regions. The average net income of the producers in each region was correlated with the probability of the risk to occur in winter and summer, autumn and spring seasons. From the Fig. 2-4, we can see that the northern region is with the most flattened probability distribution, this is an indicator of the high level of risk in this region of production. The Fig. 2-4 from the data concerned with the southern region shows that there is a degree of flatness in its probability distribution but it is not so flattened as the northern region which means that the southern region is, to a certain extent, with lower level of risk than the northern region. The probability distribution for the middle region of production seems to be the one with the lowest degree of flatness; this means that this region is with the lowest level of risk compared to the other 2 production regions.

The standard deviation: The standard deviation of the net income values for the northern, middle and southern regions are almost 511, 261 and 424, respectively. The higher SD value the higher level of risk. The northern region is with the highest SD, which means that this region is with the highest risk level since it is with the highest value of SD. The middle region is with the lowest SD, which means that this region is with the lowest risk level. The southern region is in the middle of these 2 regions but it is relatively with high level of risk.

The Coefficient of Variation (CV): The CV values are 0.36, 0.13 and 0.31 for the northern, middle and southern regions, respectively. These values are another indication of the levels of risk in the three regions. The higher the CV values the higher level of risk. The values of CV indicate the same results of SD, the northern region is with the

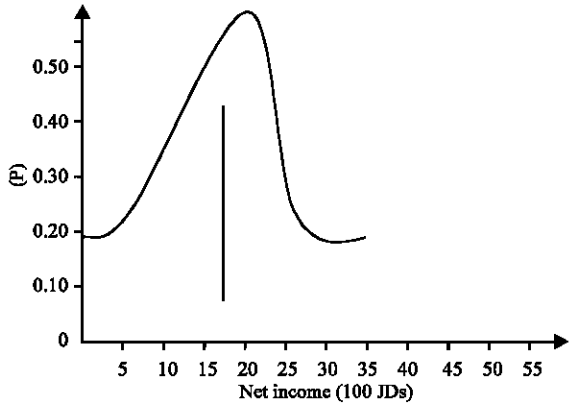

Fig. 2: Probability distribution (Northern region)

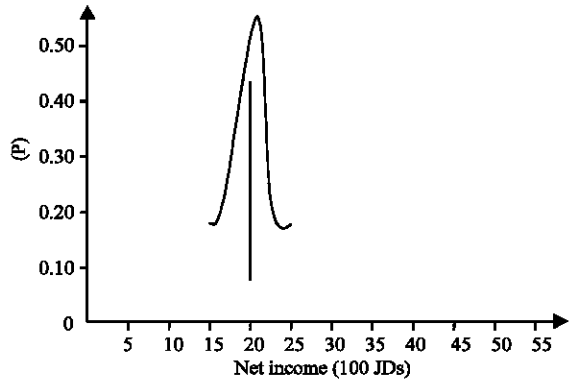

Fig. 3: Probability distribution (middle region)

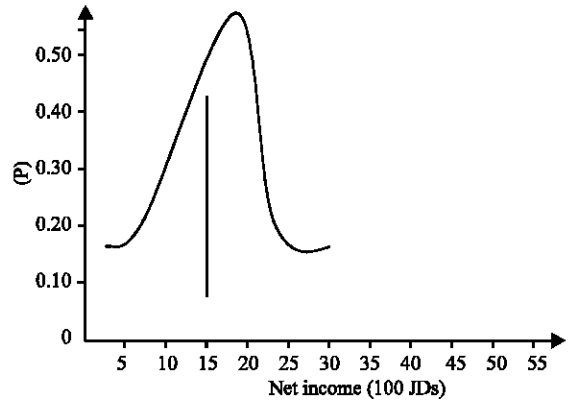

Fig. 4: Probability distribution (Southern region)

highest CV value indicating the highest level of risk and the middle region is with the lowest CV value indicating the lowest level of risk. The southern region is with high CV value compared to the middle region indicating high level of risk but it is lower than the northern region.

The Highest Lower Bound (HLB): The highest lowest bound values are almost 392, 1470 and 520 for the northern, middle and southern regions, respectively (Table 8). These values indicate the level of risk in each region of broiler production in Jordan. The highest (St.) value was in the northern region and the lowest was in the middle region, the southern region is with medium value. These values indicate that the northern region with the highest value is the most risky region; the middle region is the least risky with the least St. value. The CV values indicate that both the northern and the southern regions are with risk level three times as much as the middle region. The highest lower bound of the net income of the broiler producers indicates that producers in both the northern and the southern regions are facing more risks than those in the middle region (the lower the highest lower bound the more risky circumstances).

The results can be justified by the related climatic and topographic characteristics of each region. The northern and southern regions comprise most of the Mountain Heights Plateau of the country; the mountains are with altitudes >700 m above sea-level. These regions during the winter season (from November to March) suffers from low temperatures, which means higher climatic hazards that may negatively effects the production process mainly through increasing the costs of production. The middle region of the country is not in the same manner, it is with moderate to low level of climatic hazards that requires minimum level of precautions to be adopted by the producers to face fluctuations in temperature. The associated increase in costs of production is not noticeable as in the northern or southern regions. The worst weather is that brought by hot, dry winds from Arabia (the khamsin), which persists during autumn. These are most likely to blow in early or late summer and last for a day or 2 at a time. Under these conditions heat stress may be felt. This is the main reason for most of the producers to consider autumn to be the season with moderate level of risk. The producers adopt more cautioned measures to face the expected hazards in winter and summer more than those measures in autumn. This is another reason that autumn may be considered as a source of risk than other seasons.

Table 8: The SD, CV and the HLB of the observations

	Region		
Item	North	Middle	South
SD	511.040	260.680	424.23
CV	0.361	0.131	0310.00
HLB	392.170	1470.110	520.20

CONCLUSION

Broiler producers make decisions in a risky, ever changing environment. The consequences of their decisions are generally not known when the decisions are made and outcomes may be better or worse than expected. Weather is one of the most important sources of risk in broiler production causing variation in broiler producers net income. The importance this source of income variability differs geographically. In Jordan, the northern and southern parts of the country considered to be with high level of risk for broiler production, the middle region is with low level of risk and more suitable for broiler production. More than 60 % of broiler farms in Jordan are located in regions with high levels of risk (North and South of the country), 40 % of the whole broiler farms in the country are within the low risk region (Middle). Recognizing risky regions for broiler production businesses will aid so much in eliminating or, at least, reducing the hazardous effect of these risks, as well as, helping both the producers and the decision makers to make the correct decisions concerning risk handling and production under risk.

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