

Measuring yield and price risks for dairy farms and designing risk management strategies: the case of Tonya, Turkey

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Messung von Ertrags- und Preisrisiken für Milcherzeuger und Entwurf von Risikomanagementstrategien: das Fallbeispiel Tonya, Türkei

1. Introduction

In today's dynamic agricultural production systems, dairy farmers must not only excel in crop and animal production, but also be acute business manager, risk analyser and long-range financial planners. In addition to narrow profit margins, dairy farmers have also been subject to extreme income variability, as a result of fluctuating yields and prices.

Dairy production has still been one of the major components of Turkish agriculture, accounting for approximately 28 % of the total value of agricultural production and Trabzon province is one of the most important producer that constitute 2 % of it (SSI, 2000). The main issues of animal husbandry sector are low productivity, lack of crop diversification and high feed prices in Turkey and the same structural problems arise in Trabzon province of Turkey.

Zusammenfassung

Die Studie erarbeitet ein Modell zur Messung und Entwicklung geeigneter Risikomanagement-Strategien für Milchbauern im Tonya-Distrikt der Provinz Trabzon. Wahrscheinlichkeitsverteilungen für den Milchpreis und -ertrag werden abgeleitet, um Geschäfts- und Finanzrisiken, denen Bauern ausgesetzt sind, in den Griff zu bekommen. Nach dem Entwurf geeigneter Risikomanagementstrategien werden diese unter Verwendung der stochastischen Dominanz 2. Grades (SSD) mit den existierenden Risikomanagementstrategien verglichen. Die Resultate zeigen, dass das Gesamtrisiko der Milchbauern 57 % beträgt und sich der mögliche Verlust auf ungefähr 2000 \$ beläuft. Das Geschäftsrisiko beträgt 50 %, während die andere Hälfte finanziellen Beschränkungen zuzuschreiben ist. Die Forschungsergebnisse legen auch nahe, dass im Forschungsgebiet die am besten geeignete Risikomanagementstrategie darin besteht, das Risiko zu verlagern, um ausreichende Rückflüsse sicherzustellen, um Kredite zu bedienen und die Kosten des laufenden Betriebes zu decken. Gestützt auf die Ergebnisse der SSD-Analyse erscheint eine Einkommensdiversifikation durch Erwerb außerbetrieblichen Einkommens als bester Weg zur Risikoverlagerung für Milchbauern, gefolgt von Milchverkauf durch eine Vermarktungsgenossenschaft.

Schlagerworte: Milchwirtschaftsbetriebe, Rentabilitäts- und Risikomessung, Risikomanagementstrategien.

Summary

In this study, a model for measuring and designing appropriate risk management strategies for dairy farmers was developed in Tonya district of Trabzon province, Turkey. Probability distributions of milk price and yield are derived to expose business and financial risk faced by dairy farmers. After designing appropriate dairy risk management strategies, existing risk management strategies were compared by using second-degree stochastic dominance (SSD). The results show that the total risk of dairy farmers is 57 % and the possible loss is approximately 2000\$. Business risk is 50 % while the other half is attributed to financial rigidities. Research results also suggest that the most appropriate risk management strategy is transferring risk in order to ensure sufficient returns to meet debt services and to operate expense commitments in the research area. Based on the SSD results, income diversification through obtaining off farm income is the best way to transfer risk and marketing milk through sales cooperatives is the following alternative for dairy farmers.

Key words: Dairy enterprise, economics and risk measurement, risk management strategies.

Dairy farms in the research area operate under technical, physical and socio-economic constraints and take several input-output decisions. Risk is another issue, which affects the consequences of farmers' decision. Fluctuations in yield and prices and variations in interest payments of dairy farms led to farm income variations and large budget deficits. Since dairy farms have increasingly faced with risky situations, measuring farming risk and designing appropriate risk management strategies are vital to survive in a competitive market.

For several decades, the risk confronted by farmers is of particular interest. Many researchers have conducted studies on risk in agriculture all over the world since 1960s. Among them DAY (1965), ANDERSON (1973), JUST (1974), ROUMASSET (1976), EDER (1993) have developed models for small farms under risk. During that period, three different approaches (subjective probability approach, experimental approach and econometric approach) have been developed for solving the problem of risk measurement. Studies on risk management strategies have intensively continued during 1980–1997 period. Some of the researchers on designing and comparing risk management strategies are KING and ROBISON (1984), KLEMME (1985), MIKESSEL et al. (1988) and EPLIN and AL-SAKKAF (1995). On the other hand, recent studies on risk in agriculture have oriented to measure the efficiency of government policy on risk (see ADAMS et al., 1999; HARWOOD et al., 1999; OECD, 2000). Although these developments took place in developed countries, almost no researchers have taken risk into account in Turkey and in many other developing countries. In Turkey, researches have been conducted in agriculture assuming no risk and uncertainty due to the lack of data on farm business. However, a more sophisticated understanding of risk and risk management is important for Turkish agriculture to help producers make better decisions in risky situations and assist to policy makers in assessing the effectiveness of different types of risk protection tools. So the objectives of this research are (i) to derive probability distributions of milk price and yield, (ii) to expose business and financial risk faced by dairy farmers, (iii) to design appropriate risk management strategies to ensure sufficient returns to meet debt service and to operate expenses and (iv) to compare existing risk management strategies used on dairy farms.

2. Materials and Methods

The data used in this study were collected at several levels. Farm level data were gathered from a sample of farmers in Tonya district of Trabzon province, Turkey. Random sampling procedures were followed in selecting 44 farmers and they have been interviewed to collect the necessary input-output data. Time series data on prices of milk in the region were obtained from the documents of the Milk Cooperative and the Private Milk Foundation. In addition, the documents of General Directorate of Agriculture and perceptions of technical staff were used.

Economic analysis of dairy farms has been carried out and depending on the results the model farm, which represents all investigated farms in the area, has been described. Both subjective judgements of farmers and historical data on milk prices have been used as a base for the probability distribution. After displacing the effects of inflation on the historical data on milk price, a normal distribution has been used to elicit probabilities of milk price. Farmers generally do not keep records and thus historical data on milk yield are not available in the research area. HARDAKER et al. (1997) suggest that the triangular distribution is particularly useful in cases when no sample data are available and the distribution is to be assessed by wholly subjectively, perhaps by a farmer or an expert. So, the triangular distribution method has been used to obtain the marginal subjective probability distribution of milk yields for the sample farms in this study. Then, by using both price and yield probability distribution, conditional probability distribution for farm income has been obtained.

Risks faced by dairy farmers have been divided into two main groups such as business risk and financial risk and then these risk groups have been measured. Yield variations and price fluctuations are devoted to business risk while financial risk reflects the effects of interest payment and leverage ratio. When including interest variation and leverage differences, the probability of facing with more losses on equity rather than total asset has been used.

Appropriate risk management strategies have been designed according to the measured risk. In order to compute return to asset and equity and their respective probabilities in cooperation strategy, both the historical data on milk price paid by the cooperative milk buying price in 1990–1999 period and net worth and income statement of the model dairy farm have been used by eliminating the inflation effect from time series data. When defining the results of the cooperative strategy, the milk sales, cooperative

supplies such as feed and veterinary services have also been considered. In income diversification strategy, off farm income is taken into account when calculating return to equity. On the other hand, the case of without risk management strategy has been calculated by using milk market price and expenses. Finally, by using second-degree stochastic dominance (SSD) existing risk management strategies were compared under the assumption that the utility function is monotonically increasing and concave (risk averse situation).

3. Results and Discussion

3.1 Economic Analysis of Dairy Farms

In the research area, small size dairy farms are dominant. The size of their business is not sufficient enough to remain competitive in the market. Due to the low level of current and intermediate assets, the presence of excess labour and the efficiency of dairy farms are not at a satisfactory level. In the research area, milk yield per cow (2798 kg/year) is higher than Turkey's average (1576 kg/year), but it is lower than EU average (5842 kg/year) (SSI, 2000). The dairy farms in the research area have 3 cows in average and 3 ha farm land, their total asset is \$ 60740* (98 % of total assets are farmers own assets). The composition of the total assets seems to be unbalanced. The percentage of current assets is 2.4 % of total assets while long-term assets constitute 91 % of the total assets. Current and intermediate ratios are 4.55 and 7.63 respectively. Based on these ratios, it can be stated that there are not much serious financial problems in the dairy farms. On the other hand, return to unpaid family labour, and operator's labour, management and capital is found \$ 452. Unpaid family labour, operator's labour and management are approximately totalled to \$ 1926. Cash farm expenses constitute 69 % of the total farm expenses while 31 % of the total expenses are interest payment and depreciation. The ratio of cash farm income to cash farm expenses is 1.60 and this means that dairy farms gain \$1.6 per dollar cash farm expenses per year.

3.2 Risk Analysis of Dairy Farms

In the research area, milk price varied during the period 1990-1999. The range was between \$ 0.27/kg and \$0.33/kg. Historical data showed that milk price dispersed normally ($\chi^2=2.80$, $p < 0.05$). So, milk price probabilities

were obtained from normal probability distribution. In this research, the average value of historical milk price data has taken as a normal milk price (\$ 0.30/kg). One standard deviation below the average value has assumed as poor price (\$ 0.28/kg) while that of good price (\$ 0.32/kg) is one standard deviation above the mean. The probability for normal milk price is 0.66 while it is 0.17 for poor and 0.17 for good milk price.

In the research area the poor, normal and good yields are 1420 kg/year, 2847 kg/year and 4323 kg/year, respectively. Based on the subjective probability distribution, the probabilities for normal, poor and good yields are 0.52, 0.08 and 0.40 (Figure 1).

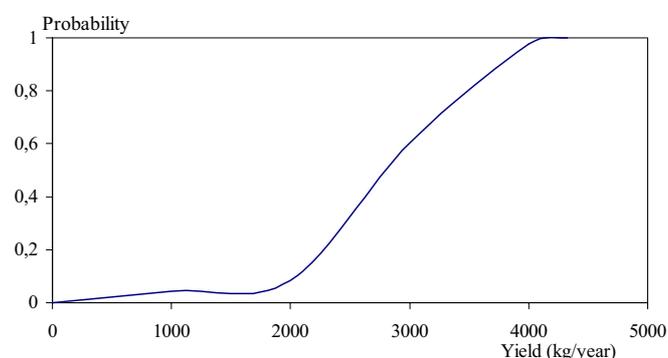


Figure 1: Cumulative Probability Density Function for Milk Yield
Abbildung 1: Kumulative Wahrscheinlichkeitsdichtefunktion für den Milchertrag

By multiplying both price and yield probabilities, conditional probabilities which reflect the fluctuations of farm income are calculated for each combination (Table 1). The probability for normal yield and price is 0.34 while that of poor yield and good price is 0.01. Dairy farms lost \$ 1485 when they were faced with poor price and yield. With price and yield increases, dairy farm incomes reached at maximum level, which was \$ 1591.

The probability of facing with losses on total asset is the first component of the business risk for dairy farms. This happens even under normal price and normal yield conditions. The second component of the business risk for dairy farms is the consequence of the losses. There is a 50 % chance of facing losses on total asset and it would be either poor yield and price, or normal yield with a normal price conditions. This is the total of business risk faced by examined dairy farms.

In addition to the business risk, the dairy farms must consider financial risk involved. Financial risk concerns the probability of facing large losses on equity rather than total

Table 1: Percent return to asset and equity and their probabilities

Tabelle 1: Verzinsung des eingesetzten Kapitals und Eigenkapitalverzinsung und ihre Wahrscheinlichkeiten

Combinations	Return to asset (%)	Return to equity (%)	Probability of occurrence	Cumulative probability
Poor yield; poor price	-2,45	-3,34	0,01	0,01
Poor yield; normal price	-2,26	-3,20	0,05	0,06
Poor yield; good price	-2,16	-3,05	0,01	0,07
Normal yield; poor price	-0,38	-1,23	0,09	0,16
Normal yield; normal price	-0,09	-0,94	0,34	0,50
Normal yield; good price	0,19	-0,65	0,09	0,59
Good yield; poor price	1,75	0,95	0,07	0,66
Good yield; normal price	2,19	1,39	0,27	0,93
Good yield; good price	2,62	1,84	0,07	1,00

asset will occur. Due to the debt factor, even good prices do not improve the poor and normal yield situation. The largest loss in terms of total asset was only 2.45 % (business risk). A loss in percent on equity was about 3.34 %. It could happen when financial risk was included. As a matter of fact, there was a 7 % of chance that the percent loss on equity was more than 2.45 %. This increased severity of loss was also due to financial risk. Since the probability of more losses on equity rather than total asset was 7 %, the total risk for dairy farms reached to 57 %.

3.3 Designing and Comparing Risk Management Strategies

Dairy farms have been facing with serious business and financial risks in the research area. Hence, they should adopt appropriate risk management strategies. BAUER and BUSHE (1993) have stated that the selection of appropriate action and strategies depends on the nature of problem or situation, the objective of business, the risk efficiency of proposed solutions, and the risk attitude of business owners. Based on the survey results, it was determined that the main target of dairy farms was to maintain their income level, to ensure sufficient returns to meet their debt service and to operate expense commitments. As mentioned before, the total risk dairy farms were faced with was 57 %, and the possible loss is \$ 1987. The amount of loss is moderate but its probability is high. Under these circumstances, avoiding or transferring risk were the most appropriate risk management strategies. Due to the absence of income loss insurance, marketing milk through sales cooperatives and income diversification by obtaining cash income from outside the farm were more suitable risk management strategies for dairy farms in the research area. Milk sales cooperative in the research area provided market and price guarantee to

its members. The cooperative also supplied concentrate feed, barn and flour in convenient terms (low price and low interest rate) to its members. The competitive power of the cooperative towards the private traders in the area resulted in regulating (or decreasing) the price in the dairy products and input markets (BOZOGLU et al., 2001).

Most of the examined dairy farms (63 %) have preferred to cooperation (Strategy 2) while 21 % of them have chosen income diversification strategy (Strategy 3). Ten percent of the examined farms have never used any risk management strategies and accepted the total risk (Strategy 1). In the purpose of comparing prevailing risk management strategies, the cumulative probability distribution function (CDF) has been estimated by using probability of occurrence and return to equity (Figure 2). Equation belonging each strategy have been estimated by means of curve estimation. Where Y reflects the probability of occurrence (%), X reflects the return to equity in the equations (thousands of dollars).

$$\text{Strategy 1: } R^2 = 0.95, F = 60.39 \\ Y = 56.99 + 54.12X - 20.10X^2 + 2.28X^3 \\ (2.90) \quad (5.63) \quad (3.19) \quad (0.485)$$

$$\text{Strategy 2: } R^2 = 0.98, F = 165.42 \\ Y = 49.76 + 50.12X - 15.47X^2 + 1.51X^3 \\ (2.03) \quad (3.93) \quad (2.23) \quad (0.34)$$

$$\text{Strategy 3: } R^2 = 0.99, F = 19709 \\ Y = -31.2 + 28.16X - 1.06X^2 + 10.52X^3 \\ (0.48) \quad (0.93) \quad (0.53) \quad (0.08)$$

Hence, obtaining off farm income is the best risk management strategy in the research area, because of the area under CDF for Strategy 3 is smaller than others

$(\int_0^{\infty} F_1(x) > \int_0^{\infty} F_2(x) > \int_0^{\infty} F_3(x))$. Cooperation strategy follows the strategy of obtaining off farm income. Accepting risk is the worst strategy for the dairy farms.

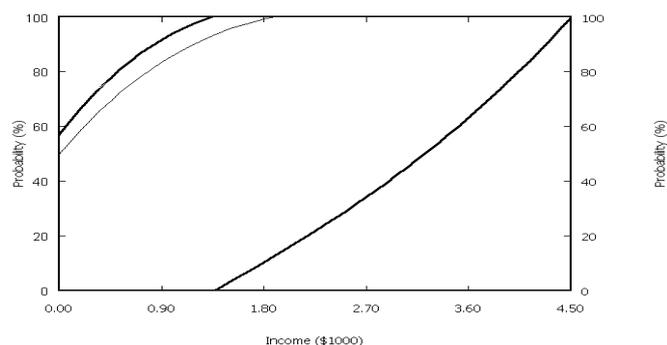


Figure 2: Cumulative Probability Density Functions for Each Risk Management Strategy in the Research Area

Abbildung 2: Kumulative Wahrscheinlichkeitsdichtefunktionen für alle Risikomanagementstrategien im Untersuchungsgebiet

4. Conclusions

The total risk to cover the debt service and operating expense-confronted dairy farms was 57 %, and the possible loss was \$1987. Based on the risk analysis results, the best risk management strategy for dairy farms was income diversification through obtaining off farm income. However, the application of this strategy was very difficult in practical life due to the presence of high unemployment rate and low education levels of farmers. Possible solutions for these problems can be stated as the creation of additional employment opportunities outside the farm sector and adapting extension programmes oriented to gain profession. On the other hand, combining cooperation strategy with income diversification strategy may increase dairy farms' resistance to combat risk. In addition, the ways to increase dairy farms' income should be explored. Increasing productivity through improved cattle population is required, modernizing poorly designed barn conditions and increasing farmers' technical information on feeding is also vital. In addition to the adoption of these strategies by the farmers, the government should apply target price and storage assistance policy instruments in order to increase farmers' income. Otherwise dramatic reduction in milk production will come to place in near future and dairy farms income will continue to decrease.

Notes

* One USA dollar was about 422000 Turkish Liras in 1999.

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