YYÜ TAR BİL DERG
(YYU J AGR SCI)
2015, 25(1): 58-68

Geliş Tarihi (Received): 04.11.2014
Kabul Tarihi (Accepted): 12.12.2014

Araştırma Makalesi/*Research Article (Original Paper)*

Analysis of the Role of Milk Yield in Sustainable Cattle Breeding Using Geographically Weighted Regression

Kenan GÖÇER

Beykent University Faculty of Engineering and Architecture, Industrial Engineering
*e-mail:gocerkenan80@gmail.com; Tel: +90 (533 733 75 18); Fax: +90 (212) 867 55 76

Abstract: The main aim of this paper is to address the question of why native cattle were shifted from native breeds to cultured and cross-breed cattle from 2000 to 2010 and to examine whether milk yield played role in those shifts. In this paper, how milk yield influences cattle production is characterized by taking into account the contribution of local geographical relationships and variations. This paper is motivated by the concern that total number of native cattle has decreased most alarmingly in Turkey. Sustainable dairy farm systems are inextricably linked with high milk yield culture cattle imported from European countries. High milk yield has become the indicator that possesses the spillover effect for the development of cattle production. The high milk yield that is abused by culture cattle systems has led to a general increase in cattle production, especially in the west and middle-south of Turkey where farmers are relatively richer.

Keywords: Dairy farm systems, milk yield, sustainable livestock systems, geographically weighted regression, geographical information system

Sürdürülebilir Sığır Islahında Coğrafik Ağırlıklı Regresyon Kullanılarak Süt Verimi Rolü Analizi

Özet: Bu makalenin temel amacı 2000-2010 arasındaki dönemde, yerli sığır yetiştiriciliğinden kültür ve melez sığırlara geçişin nedenlerinin ve geçişte süt verimliliğinin rolünün olup olmadığının saptanmasıdır. Bu çalışmada süt verimliliğinin sığır üretimini nasıl etkilediği yerel coğrafi ilişkiler ve varyasyonlar dikkate alınarak karakterize edilmiştir. Türkiye'de yerli sığırların sayılarındaki belirleyici azalma, çalışmanın temel motivasyonu olmuştur. Sürdürülebilir süt çiftlik sistemleri Avrupa ülkelerinden ithal edilen ve yüksek süt verimliliği olan kültür sığırları ile sıkı ilişki içindedir. Yüksek süt verimliliği sığır üretiminin gelişmesinde ayırdedici bir yayılma etkisine sahiptir. Türkiye'nin doğusu ve batısı süt verimliliği açısından oldukça farklılık göstermiştir. Kültür sığır yetiştiriciliği tarafından suiistimal edilmiş olan yüksek süt verimi, özelikle çiftçilerin oransal olarak daha zengin olduğu Batı ve Orta-Güney Türkiye'de sığır üretiminde genel bir artışa neden olmuştur.

Anahtar kelimeler: Süt çiftliği sistemleri; süt verimliliği, sürdürülebilir hayvancılık sistemleri, coğrafi ağırlıklı regresyon, coğrafi bilgi sistemleri

Introduction

Sustainable livestock systems have been dramatically influenced by global climate change (Nienaber et al. 1999; Naskar et al. 2012). According to Nardone et al. (2010), sustainable livestock systems can be affected by three main ways; changes to animal reproduction, animal production and livestock production systems. During pregnancy, heat stress can also lead to a slowing of the growth of the fetus (Nardone et al. 2010). Furthermore, milk quality and yield decrease under hot conditions (Bernabucci &Calamari 1998; Sejian 2012). Wolfenson et al., (2000) demonstrated that summer heat stress affects about 60% of worldwide dairy farms. When milk yield considerably decreases, cattle are slaughtered for food purposes. Accordingly, milk, eggs, and other animal products function as insurance for farmers against hard times (Herrero et al. 2010). For this reason, increasing the yield of livestock products such as milk can play a crucial role in sustainable agriculture. Therefore, understanding which factors influence milk yield becomes increasingly important.

In a sustainable dairy system, biodiversity has profoundly important role. FAO (2007), drew attention to the fact that of 7616 livestock breeds, 20 percent is at risk with respect to loss of biodiversity. The fact that meat, milk and eggs are used in profitable industrial production encourages a homogenization of species and development in-breeds due to ever-increasing demand. As a consequence, the process of genetic erosion in native breeds is accelerated (FAO 2007). At the same time, livestock biodiversity is exposed to genetic erosion because of climate change (Naskar et al. 2012). Livestock populations are influenced by natural disasters, particularly drought, and when environmental change makes a breed unfavorable in a given habitat (Blench 2005).

At the farm scale, many factors affect a sustainable dairy farm. As shown in a paper by Sturaro et al. (2013), herd size, milk yield, land use and animal biodiversity are vital to sustainable dairy farming. According to this paper, in modern dairy systems, milk yield and herd size are more than simple principles traditional dairy systems. Along with milk yield, higher milk quality on farms raises the level of sustainable efficiency (Passel et al. 2006).

Accordingly, sustainable agricultural production in traditional farms can play a vital role in rural development (Bernués et al., 2011) since sustainable dairy production is based on self-sufficient farming known as "crop-livestock systems" (Schiere et al. 2002), in which agricultural production cost is low compared to landless industrialized systems. In sustainable dairy production systems, production of affordable forage crops is an important input factor and cattle breeds with higher milk productivity are an important output factor (TZOB 2008). While decreasing feed expenses, striving to increase milk yield per cow is a vital factor that contributes to the economic profitability of a dairy farm (Rhone 2008).

As long as cattle fertility continues, milk production can be maintained for long periods of time in a sustainable dairy farm system. However, whether this system is truly sustainable is dependent on whether the milk can find an adequate market share and whether food production industries are strong. Milk production and yield are crucial for dairy farms, and inasmuch as this system is dramatically influenced by global warming over the last decade, we can see milk yield at continental scale.

Table 1. Milk productivity of cattle breeds in Turkey between 2000 and 2012

Cattle biodiversity	Milk cattle head 2000	Milk production tons 2000	Milk cattle head 2012	Milk production tons 2012	Milk yield per animal 2000	Milk yield per animal 2012
Culture cattle breed	904849	2639113	2211242	8554402	2.92	3.87
Domestic cattle breed	2039601	1501067	956758	1256673	0.74	1.31
Hybrid cattle breed	2335119	4591861	2263400	6166762	1.97	2.72

Source: TUIK (2013)

Turkey, as a developing country, has significant agricultural production and is faced with many challenges. Table 1 shows the striking changes in milk production that occurred from 2000 to 2011. The total number of cattle increased. When considering cattle biodiversity distribution, striking increases and decreases are seen. It can be seen that domestic cattle are mostly in non-commercial traditional family enterprises. Lower milk yield is likely to leading to a downtrend in the popularity of native cattle breeds. The share of culture-bred cattle is likely to increase due to their higher milk production rates.

Agricultural production has been drastically changed due to the use of more liberal economic policies that replaced planned development after 1980 (Ediger & Huvaz 2006; Hasanov et al. 2010). After the regulatory role of the state on agricultural prices was abandoned, the market was left to its own devices (Kepenek & Yentürk 2000). Turkey has experienced periodic economic crises since 1980, after each of which state agricultural supports were decreased.

Many farmers have tried to cope with the production problems that were caused by the reduced state regulatory role in the agricultural sector. Farmers adapted to these new difficult conditions by raising milk yield, which is the most important production input. As native cattle have the lowest milk productivity, their numbers have declined dramatically, from the most popular to the least. For all these reasons, native cattle are faced with extinction.

In this context, the aim of this study was to determine how farmers overcome the reduced government role in the agricultural sector and to address the question of how native cattle has been shifted to both culture and crossbred cattle from 2000 to 2010 from a geographic perspective and to examine whether milk yield plays role in those shifts. Complicating the picture is the fact that agricultural arable area is increasingly adversely affected by drought in Turkey, making it very difficult to maintain the crop livestock farming systems that have traditionally been dominant. Accordingly, milk yield in sustainable dairy systems becomes even more important.

This paper is motivated by the concern that the total number of native cattle has decreased alarmingly. The study seeks answers to the questions: "What role have milk yield and production played in overcoming process from geography to geography?" and "How does cattle biodiversity differ with respect to milk yield?". This study demonstrates that milk yield and production are vital to sustainable livestock systems with regard to self-sufficiency. In order to address this objective, the relationship between milk yield and cattle potential was explored by using geographically weighted regression.

Material and Methods

The regions are shown in Figure 1. The data for the years 2000 and 2010 used in this study were provided by the Turkish Statistical Institute (TUIK) (TUIK 2013). The numerical variables for cattle divided into three categories, culture, and hybrid and indigenous were included in the model. The milk yield variable represents average amount of milk production per year in tons for each cow. Milk yield is an independent variable while the number of cattle is dependent. No autocorrelation problem was detected. White-test was performed in order to test whether the problem of heteroscedasticity was present. Variables were log-transformed in order to eliminate heteroscedasticity problems.

This study aimed at investigating the effect of milk yield on dairy cattle numbers taking breed into consideration. The conventional ordinary least squares (OLS) analysis yields a regression coefficient that represents all regions in order to explain the relationship between two variables in such a study. In the application of the conventional OLS technique in this study, it was assumed that the distribution of the relationship between milk yield and cattle numbers was uniform in the 923 districts of Turkey.

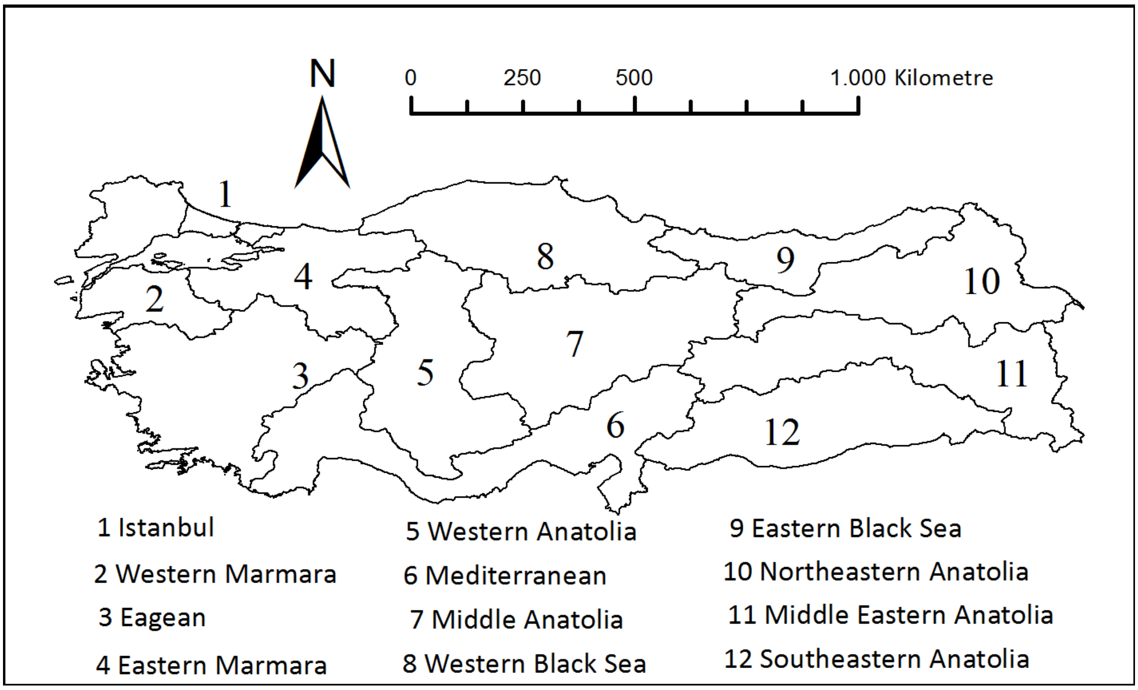

Figure 1. Map of Turkey's regions

However, the use of geographically weighted regression (GWR) technique gives better results since deeming the relationship between two variables with uniform spatial non-stationary feature is likely to result in data loss (Fotheringham et al. 2002). Therefore, GWR technique was preferred in this study. GWR calculates individual regression coefficients for the relationships between two variables at each location in a region. Analyses of agricultural production using GWR are quite widespread in recent years due to the proliferation of data generation for geographic information systems (Farrow et al. 2005; Tu 2011; Sage & Goldberger 2012; Su et al. 2012; Yang et al. 2013; Gocer 2014; Manca et al. 2014; Sang et al. 2014; Huang et al. 2015).

Spatial variation is an important aspect of environmental issues. In the characterization of the adverse effects of global warming on agricultural production across the world, the most striking point is the heterogeneous geographical distribution of dramatic adverse effects. (Barnwal & Kotani 2013). Tu (2011) applied the GWR technique because the conventional OLS technique accepts the geography as constant in the analysis of the relationship between land use and water quality. In their study, it was found that the relationship between watershed characteristics and pollution varied based on location. Similarly, as a natural consequence, environmental pollution leads to considerable regional differentiation in organic agricultural productivity. In some regions, the opportunity to engage in organic agriculture has already been lost due to this differentiation. Sage & Goldberger (2012) studied the role of geographical effects on the productivity of organic agriculture. In this study, the GWR technique was preferred as the area had a spatial non-stationary property. The application of GWR resulted in a better understanding of the causes of variations in organic agricultural productivity. Farrow et al. (2005) conducted a study of malnutrition in Ecuador. In this study, to which extent malnutrition was spatially clustered was explained using GWR analysis. Another study was conducted by Sang et al. (2014), in which the GWR technique was applied in order to measure the impacts of agricultural support systems in Norway. In this study, it was found that there were differences between regions in the agricultural support system. How a region could dominate in the national statistics was explained through this differentiation. Yang et al. (2013) analyzed the relationship between the production of cereals and grain planting area, effective irrigation and mechanization of agriculture in the Yellow River Delta in China. In this study, again the GWR technique was preferred due to the spatial non-stationary characteristics of the correlations. The independent variables were found to effectively demonstrate differences based on location of grain production.

The GWR model is an extension of the global regression locally. Considering all the relations across the area as uniform, the conventional regression coefficient (OLS) model is set up as follows:

$$Y = \beta_0 + \beta_1 x_1 + \ldots\ldots \beta_p x_p + \varepsilon \qquad (1)$$

where $x_1$and x_p are independent variables, β_0 is constant, $\beta_p$are coefficient estimates, Y is dependent variable and ε is an error term. The GWR yields local parameters rather than global parameters in equation (2) as follows;

$$y = \beta_0(u_j, v_i) + \sum_{i=1}^{k} \beta_i (u_j, v_i) x_{ij} + u_j y = \beta_0(u_j, v_i) + \sum_{i=1}^{k} \beta_i (u_j, v_i) x_{ij} + u_j \qquad (2)$$

where u_j and v_j demonstrate the spatial positions of district j, $\beta_i(u_j,v_j)$ is the local estimated coefficient for the milk yield variable, x_k at point i, $\beta_0(u_j,v_j)$ is the intercept for district j and u_j is the random error term at location i.
The local parameter vector in equation (3) is estimated as follows;

$$\beta_i = (x' W_i \; x)^{-1} x' W_i \; y \beta_i = (x' W_i \; x)^{-1} x' W_i \; y \beta_i = (x' W_i \; x)^{-1} x' W_i \; y \qquad (3)$$

$W_i W_i$in equation (4) represents the diagonal weight matrix with (nxn) dimensions consisting of $w_{ij} w_{ij}$ (1,2,3.........n);

$$W_i W_i = \begin{bmatrix} w_{i1} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & w_{in} \end{bmatrix} \begin{bmatrix} w_{i1} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & w_{in} \end{bmatrix} \qquad (4)$$

The GWR weight matrix is calculated for each i and these weights vary according to the position of each i^{th} polygon. When the distance between the positions of i and j is considered as d_{ij}, the weights increase with decreased distance between the two positions as a function of d_{ij}. Thus, closer positions have greater weights. The weight function used herein is shown as follows (Fotheringham et al., 2002);

$$w_{ij} = \exp\left[-\frac{\left(d_{ij}/h\right)^2}{2} \right] w_{ij} = \exp\left[-\frac{\left(d_{ij}/h\right)^2}{2} \right] \qquad (5)$$

where h is identified as bandwidth. The data weights vary depending on the distance between i and j. As the distance increases, the weights decrease depending on the function in equation (5) (Fotheringham et al., 2002). If the distance between i and j increases, the weight will move closer to zero and thus the interaction of close locations will be better measured. In other words, without taking into account the interactions between distant geographical locations, the differentiation in the area will be revealed. Even if the relationship between two variables is negative or positive at different regions, such a difference can be reflected to the area by means of using the GWR technique.

The main purpose of comparing GWR with OLS is to demonstrate whether or not GWR has a better performance than OLS. By comparing R^2 and AIC values, it can be determined which model is more suitable (Tu & Xia 2008). Higher R^2 values demonstrate that the variance in the dependent variable is better expressed by the independent variable while lower AIC values indicate a better performance of the model (Wang et al. 2005; Tu & Xia 2008). In this study, it was found that the GWR model yielded better AIC value results compared to those of OLS (Table 3).

Results and Discussion

GWR model, which estimates coefficients of the independent variables for each district, was used to characterize how milk yield influences cattle production across the study area. In other words, GWR determined whether there is a significant spatial non-stationary relationship between the milk yield and cattle production across regions. Before GWR analysis, the first step was to question whether the effect of milk yield as an independent variable remains constant over the cattle production as a dependent variable across the geography. In order to measure the effect of milk yield on the number of cattle according to the breed, the GWR model of the log-transformed variables is as follows;

For each equation below, $i = 1,2,3 \ldots \ldots \ldots \ldots 923$

$$Crossbread\_Milk\_yield_i = \beta_{0i} + \beta_{1i}\, Crossbread\_.cattle_i + u_i \quad (6)$$

$$Culture\_Milk\_yield_i = \beta_{0i} + \beta_{1i}\, Culture\_.cattle_i + u_i \quad (7)$$

$$Native\_Milk\_yield_i = \beta_{0i} + \beta_{1i}\, Native\_.cattle_i + u_i \quad (8)$$

For a district called Hamzagözü from Amasya, the Equation 9 has been produced by using Equation 8. For all 923 district GWR results are given in Graph 2 and 3, respectively.

$$Native\_Milk\_yield_{Hamam\,ozu} = 0.223 + 7.42 + 0.37 \quad (9)$$

Table 2 shows explicitly that the considerable spatial variability in milk yield and cattle production indicates a significant spatial non-stationary relationship between variables given that coefficients of independent variables (b) range from negative to positive. In order to select the best solution, Akaike's Information Criterion (AIC) of GWR can be compared with the Akaike's Information Criterion (AIC) of OLS (Wang et al., 2005; Tu & Xia 2008). AIC results from GWR demonstrated better solutions than that of OLS (Table 3). The AIC results from the GWR model were lower than those from the OLS model, which account for that fact that the GWR was a better fit than OLS model.

Table 2. Summary of the slope parameter from the GWR analysis

Dependent variable Number of cattle	Year	Independent variable milk yield from	Coefficient (b) min-max	t statistics min-max
Culture cattle	2000	Culture cattle	-0.43 - 0.70	-2.12 - 6.43
Native cattle	2000	Domestic cattle	-5.82 - 9.69	-7.91 - 6.68
Hybrid cattle	2000	Hybrid cattle	-2.02 - 2.26	-4.21 - 5.60
Culture cattle	2010	Culture cattle	-0.20 - 0.75	-0.10 - 7.11
Native cattle	2010	Domestic cattle	-9.01 - 9.32	-10.86 - 7.59
Hybrid cattle	2010	Hybrid cattle	-0.43 - 0.90	-1.12 - 5.42

Figures 2 and 3 show how the relationship between milk yield and cattle production fluctuates throughout the country as a result of the GWR analysis for 2000 and 2010. It is critical to recognize these differences by regions in which the effects of milk yield on the sustainable farmer system are estimated.

Figures 2a, 2d, 2g, 3a, 3d, and 3g show that the coefficients (b) fluctuate negative to positive across the country. In those figures, dark blue district clusters express a negative relationship between milk yield and cattle production variables and red, orange and light blue indicates that both dependent and independent variables have changed in the same direction. Figures 2c, 2f, 2i, 3c, 3f, and 3i show R-squared results for each district. The variation of local R-squared, which explains different localization, shows the relationship between milk yield and cattle production. There are of course dark green clusters, indicating a strong relationship between the variables relying on the R-squared. The t-statistics map shows whether there is a statistically significant relationship between the variables for each district. Some of the t-values, indicated by white color in Figures 2b, 2e, 2h, 3b, 3e, and 3h, are statistically insignificant at a 0.05 level (t-values lower than 1.96 or above -1.96).

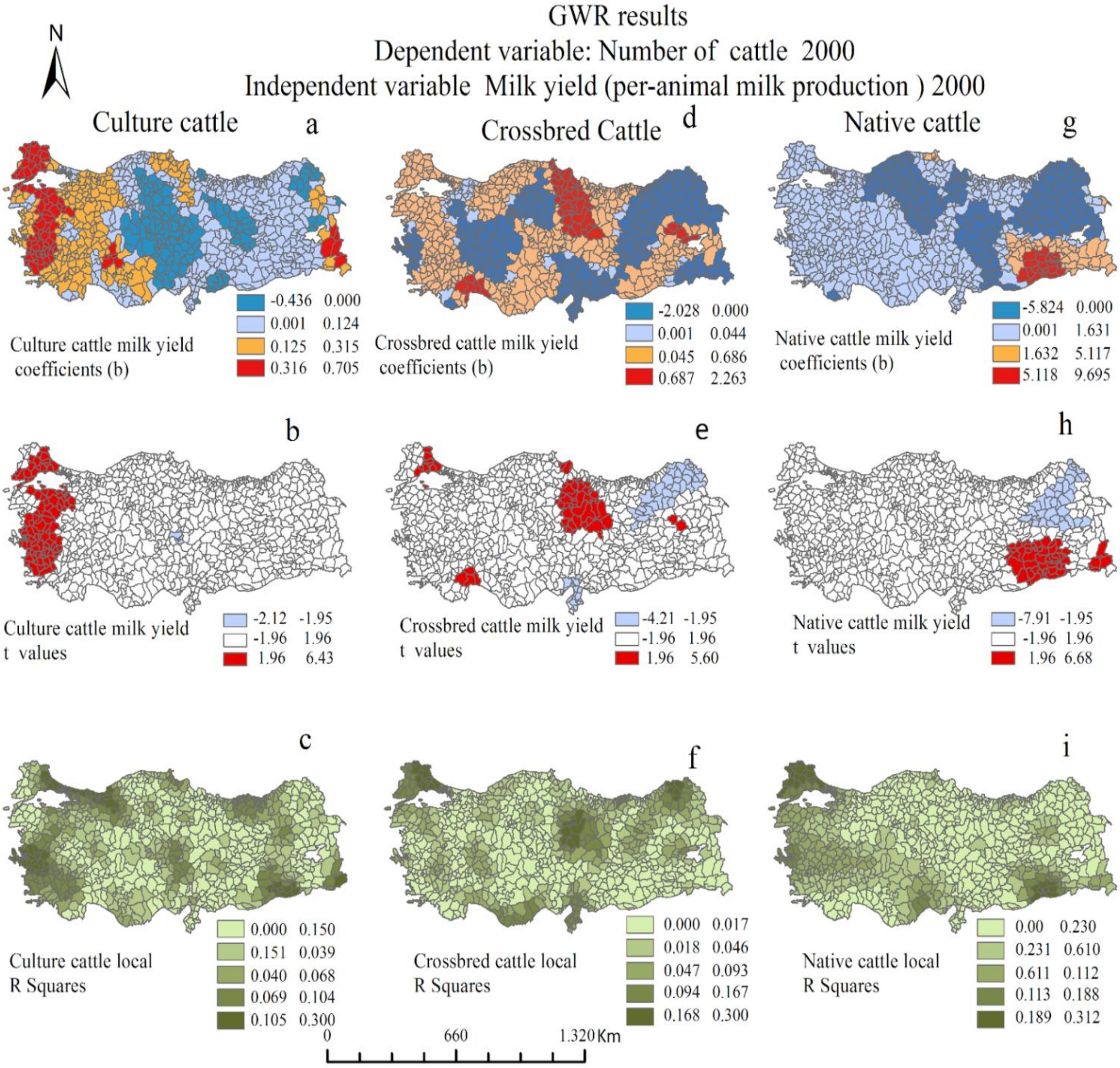

Figure 2. Spatial distribution of local coefficients, R-squared and t-statistics from the GWR for 2000. T-values are significant in some districts (p<0.05 level, t-values above 1.96 and lower than -1.96)

Table 3. Model performance as judged by AIC_{GWR} and AIC_{OLS}.

Dependent variable Number of cattle	Independent variable milk yield	Year	AIC_{OLS}	AIC_{GWR}
Culture cattle	Culture cattle	2000	17808.7	17720.4
Domestic cattle	Domestic cattle	2000	19012.1	18480.6
Hybrid cattle	Hybrid cattle	2000	18789.6	18720.2
Culture cattle	Culture cattle	2010	18962.4	18868.5
Domestic cattle	Domestic cattle	2010	18993.2	18293.3
Hybrid cattle	Hybrid cattle	2010	18680.3	18383

As can be seen in Figure 3g, milk yield coefficient ranged from -9.01 to 9.32 in 2010. Those results explicitly account for relationships between milk yield from native cattle and number of native cattle spatial heterogeneity distributions. Positive coefficient values are found in center of North and Middle Eastern Anatolia and western part of South Eastern Anatolia (Figure 3g). Interestingly, negative coefficient values in Northeastern Turkey are immediately adjacent to positive coefficients. Negative relationships between the milk yield and cattle production are seen in Northeastern Anatolia, which is most developed with regard to amount of native cattle. In this region, the reason that negative relations are found is that many native cattle, as a consequence of low level milk yield, were withdrawn from the agricultural system after the 2000 economic crises (BSB 2008).

Additionally, it is seen that milk yield rose because the number of native cattle decreased. When the 2000 GWR analysis is compared with 2010, the negative relation in 2000 shifted to a positive relation in North and Middle Eastern Anatolia (Figure 2g, and 3g respectively). This case is profoundly important with regard to conservation of biodiversity, although native cattle milk yield is less than that of culture cattle. Meanwhile, Northeastern Anatolia has largest area that is convenient for pastoral livestock agricultural systems (TUIK 2001).

In order to understand the reason why this difference is seen in this part of the North, Figure 4 can be compared with Figure 3. This Figure shows how the milk production unions (MPU) are distributed across Turkey by districts. Black color clusters in Figure 4 reflect how raw milk is collected and is integrated with the milk production chain. In other words, farmers meet sustainability conditions in those districts or their neighbors because of the MPU. We can say that the marketing problem in the dairy farmer system can be overcome easily through development of an MPU in districts that lack one currently. When looking from a different angle, Northeastern Anatolia has the largest pastoral area that is well-suited for grassland livestock. However, net migration is highly negative in those regions, sustainable agricultural production is at risk.

As for crossbred cattle, Figure 2d, 2e, 2f and Figure 3d, 3e, 3f representing 2000 and 2010 respectively, show the changing local relationship between the number of cattle and milk yield. Local relations between variables from West to East across the study area varies more distinctly. Additionally, local relations between the milk yield and crossbred cattle in the east strengthened considerably in 2010 (Figure 3d). On the other hand, these local relations become negative in the west and they partially weakened in middle-north of Turkey. The strongest positive relationship shifted from west to east over this time frame. Considering this subject in a bit more depth, farmers' income level declines from west to east. The fact that farmers with low income level in the northeast bred native cattle with culture cattle to obtain crossbred cattle is more economical than directly buying culture cattle. In the west, farmers with a relatively high level income can afford to have culture cattle. In other words, after the 2000 economic crisis, farmers with low income attempted to overcome and adapt the new difficult economic conditions by raising cattle biodiversity so that they could raise sustainability limits.

The maps in Figure 2a, 2b, 2c for 2000 and Figure 3a, 3b, 3c for 2010 show striking evidence of how local relations between milk yield and culture cattle productions changed. Notably, Figure 3a emphasizes the wide range of the coefficients (b) of the independent variable. In this map, positive local relations are seen in western Marmara, Aegean and South middle Anatolia regions. In particular, when we consider that those western regions have per capita income more than three times that of the Eastern regions, Northeastern Anatolia and Southeastern Anatolia. Western regions have profoundly important advantages from the point of view of sustainable agriculture over eastern regions; western farmers can breed culture cattle with milk yield more than 3 times greater than that of native cattle (Table 2).

As seen in Figure 4, MPUs are unevenly distributed in the eastern half of Turkey as opposed to the western half. Figure 4 draws attention to fact that many districts in Western regions along with their neighbors where farmers have organized as milk collection unions do not have marketing problems. Because milk production unions provide farmers with a link to the rest of the milk production chain, they have direct impacts on the national milk production chain. However, those regions do not have clear climate or pastoral area advantages compared to Northeastern Anatolia.

In Turkey, the decline of support provided by governments to farmers because of the economic crises have made agriculture conditions difficult. Farmers adapt to these new difficult conditions by raising milk yield from culture cattle and crossbred cattle instead of native cattle. This presents a difficult situation given that on the one hand, milk yield is crucial for sustainable dairy farming, but on the other hand, the protection of native cattle is generally important for ecological sustainability. In other words, while raising milk yield from culture cattle instead of native cattle positively contributes to sustainable dairy farming, the fact that native cattle is risk of extinction adversely affects general species sustainability. Accordingly, we can say that increasing milk yield should not be maintained at the expense of abolishing native cattle.

The maintenance of sustainable dairy farm systems is dependent on whether the milk can find adequate market share and whether the food production industry is well established. In Turkey, one of the most important problems for the dairy processing industry is maintenance of consistent quality of raw milk. In Eastern Anatolian regions, the reason why dairy farming faces sustainability problems is that the agricultural industry and its marketing are not adequately developed and widespread compared to the west. Concurrently, milk production unions (MPU) are likely to be contributing factors in the milk supply chain.

Eastern and Western Turkey were more differentiated with respect to the local relationship between milk yield and number of cattle in 2010 than they had been in 2000. Western Marmara region and middle South Anatolia regions have always been the richest regions of the country with both culture cattle and milk yield higher than that of the rest of Turkey.

In order to be integrated with the national milk production chain, especially in eastern Anatolia, milk collection centers have to be exist in certain geographic regions. Those centers that preserve the high-quality of raw milk can link between the dairy farms and national milk industry distribution systems. A dairy farm system will be able to be overcome sustainability problems with regards to getting raw milk to market easily.

The easiest way to soften the hardship of economic crises for farmers is to choose to culture cattle which have high milk yield. However, the sole determinative factor for a sustainable dairy farm system is not milk yield. Further research is required to analyze how other factors influence dairy farm systems.

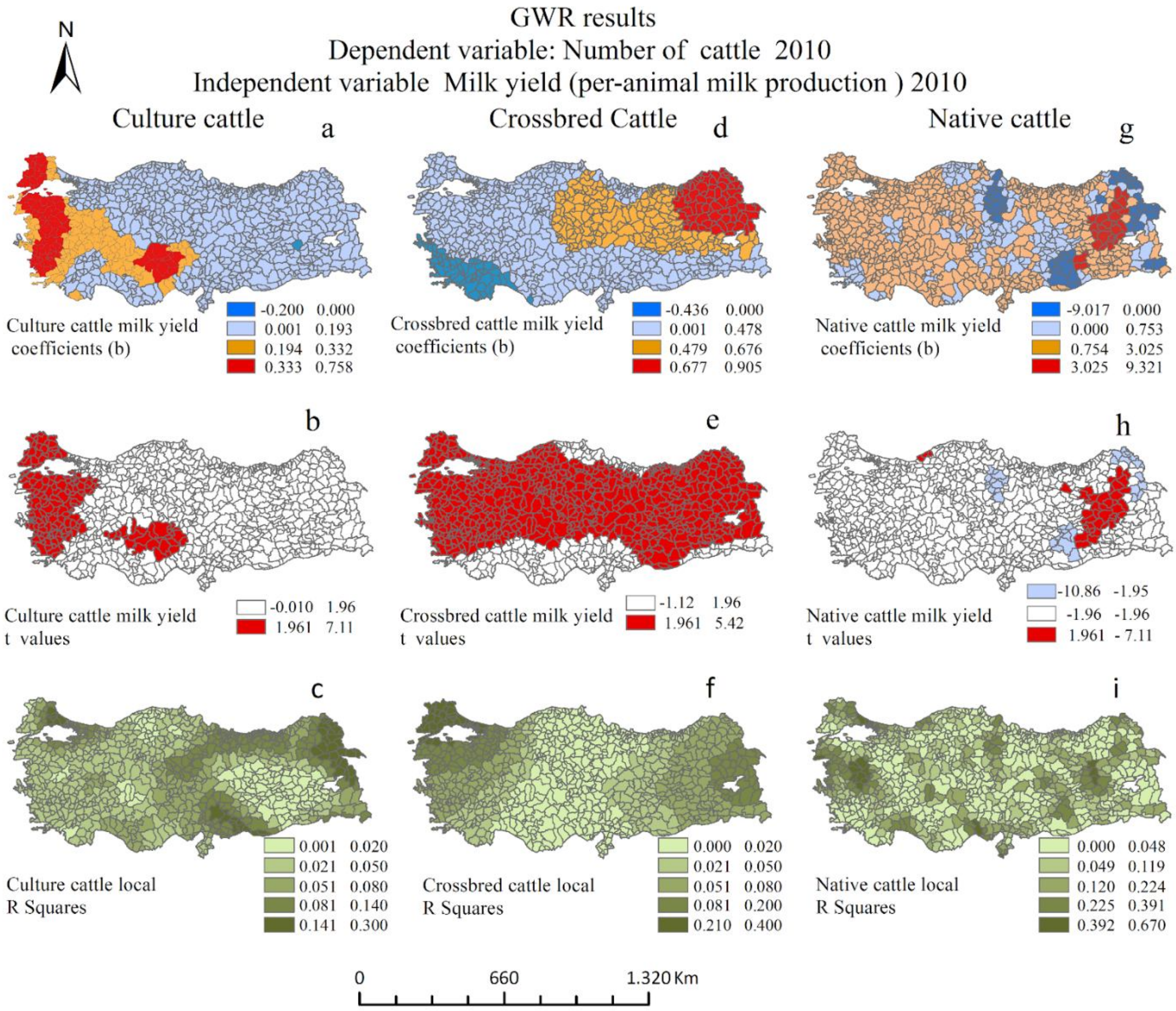

Figure 3. Spatial distribution of local coefficients, R-squared and t-statistics from the GWR for 2010. T-values are significant in some districts (p<0.05 level, t-values above 1.96 and lower than -1.96).

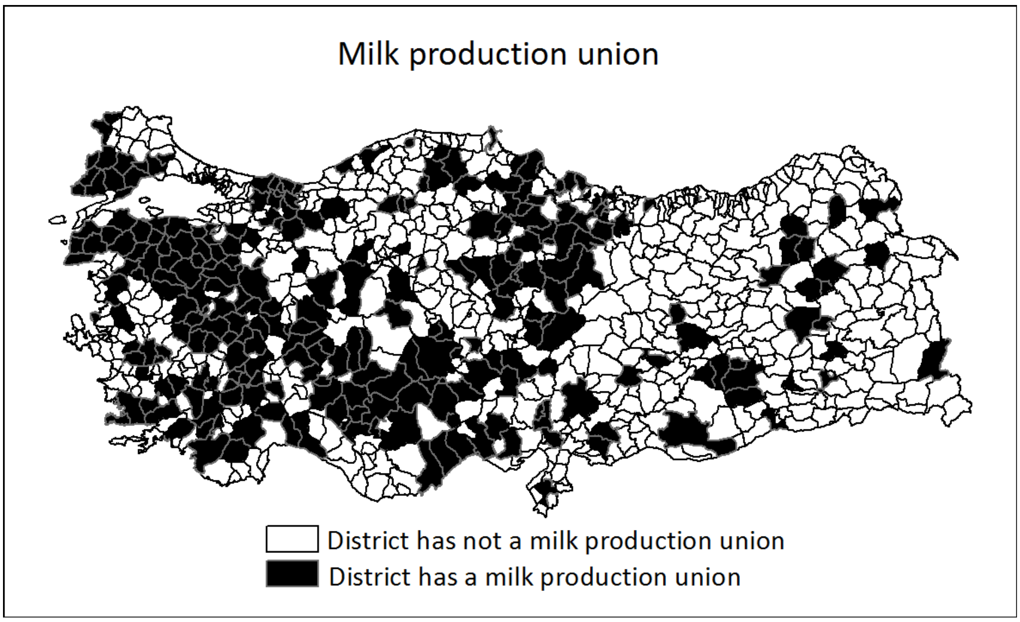

Figure 4. Distribution of milk production union. Source : SUTBIRLIK (2013)

References

Barnwal P, Kotani K (2013). Climatic impacts across agricultural crop yield distributions: An application of quantile regression on rice crops in Andhra Pradesh, India. Ecological Economics, 87: 95-109.

Bernabucci U, Calamari L (1998). Effects of heat stress on bovine milk yield and composition. Nutrizione Animale. 24 (6): 247–257.

Bernués A, Ruiz R, Olaizola A, Villalba D, Casasús I (2011). Sustainability of pasture-based livestock farming systems in the European Mediterranean context: Synergies and trade-offs. Livestock Science. 139 (1/2): 44-57.

Blench R (2005). Conservation of indigenous livestock: sustaining biodiversity for current and future generations. In: Presentation in CGIAR annual general meeting 6th Dec 2005. Marrakech, Morocco.

BSB (2008). 2008 Kavşağında Türkiye siyaset iktisat ve toplum. Yordam, Istanbul.

Ediger VS, Huvaz O (2006). Examining the sectoral energy use in Turkish economy (1980–2000) with the help of decomposition analysis. Energy Conversion and Management 47 (6):732–745.

FAO (2007). The State of the World's Animal Genetic Resources for Food and Agriculture -in brief. Rome.

Farrow A, Larrea C, Hyman G, Lema G (2005). Exploring the spatial variation of food poverty in Ecuador. Food Policy, 30(5): 510-531.

Fotheringham A S, Brunsdon C, Charlton M (2002). Geographically Weighted Regression: The Analysis of Spatially Varying Relationships. Wiley, Chichester.

Gocer K. (2014). Analysis of changes in grain production on fruit and vegetable cultivation areas in Turkey through geographically weighted regression. Scientific Research and Essays. 9 (12): 540 - 547.

Hasanov M, Ayşen A, Telatar F (2010). Nonlinearity and structural stability in the Phillips curve: Evidence from Turkey. Economic Modelling 27 (5): 1103–1115.

Herrero M, Thornton PK, Notenbaert AM, Wood S, Msangi S, Freeman HA, Bossio D, Dixon J, Peters,M, van de Steeg J, Lynam J, Parthasrathy Rao P, Macmillan S, Gerard B, McDermott J, Seré C, Rosegrant M (2010). Smart investments in sustainable food production: revisiting mixed crop livestock systems. Science 327(5967): 822–825.

Huang J, Huang Y, Pontius R G, Zhang Z (2015). Geographically weighted regression to measure spatial variations in correlations between water pollution versus land use in a coastal watershed. Ocean and Coastal Management, 103: 14-24.

Kepenek Y, Yentürk N (2000). Türkiye ekonomisi. Remzi kitapevi, Istanbul.

Manca G, Attaway DF, Waters N (2014). Program assessment and the EU's agrienvironmental Measure 214: An investigation of the spatial dynamics of agrienvironmental policies in Sardinia, Italy. Applied Geography, 50: 24-30.

Nardone A, Ronchi B, Lacetera N, Ranieri MS, Bernabucci U (2010). Effects of climate changes on animal production and sustainability of livestock systems. Livestock Science. 130 (1-3): 57–69.

Naskar S, Gopal GR, Chopra A, Chandan C, Prince LLL (2012). Genetic Adaptability of Livestock to Environmental Stresses, pp. 335-337, In: Environmental Stress and Amelioration in Livestock Production, Sejian V, Naqvi SM K, Ezeji T, Lakritz J, Lal R (eds), Springer-Verlag Berlin Heidelberg.

Nienaber JA, Hahn GL, Eigenberg RA (1999). Quantifying livestock responses for heat stress management: a review. International Journal of Biometeorology. 42 (4): 183-188.

Passel SV, Mathijs E, Van Huylenbroeck G (2006). Explaining Differences in Farm Sustainability: Evidence from Flemish Dairy farms. In: Contributed paper prepared for presentation at the International Association of Agricultural Economists Conference. Gold Coast, Australia, August 12-18, 2006. Scottish Agricultural College, 2006. The Farm Management Handbook 2006/07. SAC. Edinburgh.

Rhone A (2008). Factors Affecting Milk Yield, Milk Fat, Milk Quality, And Economic Performance of Dairy Farms in The Central Region of Thailand University of Florida. Doctorate topics, pp. 26-29.

Sage JL, Goldberger JR (2012). Decisions to direct market: Geographic influences on conventions in organic production. Applied Geography, 34: 57-65.

Sang N, Dramstad WE, Bryn A (2014). Regionality in Norwegian farmland abandonment: Inferences from production data. Applied Geography 55: 238-247.

Schiere J, Ibrahim MNM, Keulen H (2002). The role of livestock for sustainability in mixed farming: criteria and scenario studies under varying resource allocation. Agriculture Ecosystems and Environment. 90 (2): 139–153.
Sejian V, Naqvi S M K, Ezeji T Lakritz J & Lal R (2012). Introduction. Sejian V Naqvi S M K Ezeji T, Lakritz J & Lal R (eds.), Environmental Stress and Amelioration in Livestock Production, Springer-Verlag Berlin Heidelberg. pp. 1-12.
Sturaro E, Marchiori E, Cocca G, Penasa M, Ramanzin M, Bittante G (2013). Dairy systems in mountainous areas: Farm animal biodiversity, milk production and destination, and land use. Livestock Science. 158 (1): 157-168.
Su S, Xiao R, Zhang Y (2012). Multi-scale analysis of spatially varying relationships between agricultural landscape patterns and urbanization using geographically weighted regression. Applied Geography, 32 (2): 360-375.
SUTBIRLIK (2013). Türkiye süt üreticileri merkez birliği. Avaliable on the internet: http://www.sutbirlik .com/.Accessed 15 January 2014.
Tu J, Xia ZG (2008). Examining spatially varying relationships between land use and water quality using geographically weighted regression I: model design and evaluation. Science of the Total Environment 407 (1): 358 -378.
Tu J (2011). Spatially varying relationships between land use and water quality across an urbanization gradient explored by geographically weighted regression. Applied Geography, 31(1): 376-392.
TUIK (2001). Agricultural census village information. Turkish Statistical Institute . Ankara.
TUIK (2013). Livestock statistics. Turkish Statistical Institute, Ankara. Available on the internet: http://tuikapp.tuik.gov.tr/hayvancilikapp/hayvancilik.zul. Accessed 10 October 2012.
TZOB (2008). Türkiye Süt Sektörünün Değerlendirilmesi 2008 Yılı ve Sonrası Beklentiler. Türkiye Ziraat Odaları Birliği. ANKARA.p. 25-26
Wang Q, Ni J, Tenhunen J (2005). Application of a geographically-weighted regression analysis to estimate net primary production of Chinese forest ecosystems. Global Ecology and Biogeography, 14(4): 379-393.
Wolfenson D, Roth Z Meidan R (2000). Impaired reproduction in heat stressed cattle: basic and applied aspects, Animal Reproduction Science, 60–61: 535–547.
Yang Y, Tong X, Zhu J. (2013). A geographically weighted model of the regression between grain production and typical factors for the Yellow River Delta. Mathematical and Computer Modelling, 58(3): 582-587