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FUTURE TRENDS OF RED MEAT PRODUCTION IN PAKISTAN: TIME SERIES ANALYSIS

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ABSTRACT

Meat specifically red meat is an important source of high-quality proteins, fibre, iron and vitamins in the diet of people. The demand of meat and meat products is rising day by day due to the rapid population growth. But the traditional system is not able to meet this growing demand and it is necessary to tackle the upcoming situations. Production of red meat may fluctuate due to droughts, Foot-and-Mouth Disease Virus (FMDV) and an early age of slaughtering. For this, forecasting is the main tool which is used to determine the production of red meat in coming years. In this study, we use time series data from 1996-2019 to forecast next six years for red meat production of Pakistan. Different time series models are fitted to select the most suitable one. Results concluded that the random walk model with drift is the most suitable model because of minimum AIC and SBIC values. This model is further used for forecasting purposes for the time periods 2020-25. Red meat production of Pakistan may expect to be increasing 15.81% in 2025 as compared to 2019.

Keywords: AIC, Forecasting, Production, Red meat and Time series models

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INTRODUCTION

Higher average age is a representation of well-nourished country. Balanced diet is the key factor for achieving such purpose. According to experts, fruit, vegetables, grains and meat should be consumed in a proper amount for being healthy. Consumption of meat especially red meat is a kind of status symbol in our rural areas. Indeed, the annual meat consumption per capita in the nation is the indication of flourished economy.

In Asia, more than in numerous parts of the world, the utilization of red meat is changing significantly and quickly because of the pace of financial development in Asia and nearby countries. Rapid increase in population results a growing need of sustenance and the difficulties of worldwide environmental change, have brought about numerous livestock researchers in Asia concentrating on the improvement of economic ruminant production systems. So, it is necessary to enhance the ecological sustainability of the production of livestock while expanding profitability to fulfil future needs.

Pakistan is a country with topography and ecological conditions appropriate for the production of red meat. Livestock division plays a crucial role to raise the economy of Pakistan. It is very work escalated and involves a large man power. The farming division is the spine of Pakistan's economy that gives a crude material in order to run the industries and reduce the ratio of poverty. Livestock contributes roughly 19.8% in gross domestic product (GDP) and employer absorbing 42.3% of the country's labour force. Livestock division contributes about 58.92% to overall agriculture GDP (Qasim *et al.,* 2019) and nearly 11.6% of the contribution are overall GDP during 2016 contrasted with 56.4% and 11.7% respectively a year ago (GOP, 2015).

Meat and meat items are the most imperative source of high-quality protein, iron and nutrients for the people of Pakistan. Interest in meat and its items is raising because of the heavy population growth. Traditional arrangement of meat is not a good technique to fulfil this increasing interest of quality meat as shown by continuous increase in the cost. The best solution to tackle this problem is to enhance the productivity of meat. Red meat in Pakistan is customarily a by-product of the dairy sector. Iqbal and Ahmad (1999) concluded that many by-products i.e., wool, fats, butter and leather items play an important role to earn foreign exchange in Pakistan to strengthen the economy. In Pakistan, the production of red meat depends on old-style practices, which is not an efficient technique. In Pakistan, the gap between demand and supply of meat is 4.1% per annum (PBIT, 2011). In order to compete in the world meat market, Pakistan should enhance its production. Pakistani meat has a good taste so that's why meat and meat items are being exported to other countries including Middle Eastern countries such as, Kuwait, Qatar, Bahrain, United Arab Emirates, Oman and so forth. In the last six years, the production of red meat shows an increasing trend. Yearly meat production expanded from 251500t to 3232000t and the annual growth is about 4.8% during 2006-12 (Bashir *et al.,* 2015). Moreover, the highest

annual growth rate of poultry, mutton and red meat which is recorded by the GOP in 2006 and 2012 is 10.5%, 2.3% and 3.7% respectively.

Table 1: World Red Meat Production: Ranking of Countries (2017-2018).

	World	61,583,000	
Ranks	**Country**	**2018**	**% of World**
10	Turkey	1,700,000	2.76%
9	Pakistan	1,780,000	2.89%
8	Mexico	1,910,000	3.10%
7	Australia	2,065,000	3.35%
6	Argentina	2,760,000	4.48%
5	India	4,250,000	6.90%
4	China	7,070,000	11.48%
3	European Union	7,875,000	12.79%
2	Brazil	9,500,000	15.43%
1	United States	12,086,000	19.63%

Source: U.S. Department of Agriculture, Foreign Agricultural Service, Livestock and Poultry: World Markets and Trade, annual. http://www.fas.usda.gov/currwmt.asp, Internet release 2010.

The red meat production statistics for the year 2017-2018 released by the United States Department of Agriculture shown in Table 1. According to this table, the world's maximum production of red meat is in the United States with a 19.63% during 2018. Moreover, Pakistan is among the 9th number with a total production of 1,780,000 (2.89%) thousand tons.

According to the Gallup survey, the majority of people prefer to eat meat over vegetables and pulses i.e. the rough percentage of these people is 59% whose preference is meat. Moreover, the results demonstrated that meat is the most basic nourishment diet; nonetheless, 52% of them are those whose first preference is meat, 37% prefer vegetables while the remaining 10% people would like to eat pulses. Throughout the years, numerous fluctuations have been seen in the production of meat in the country (Gallup Pakistan, 2009).

In future, interest of meat items increases at very higher rates induced by different influences such as increasing the population, increasing protein and calcium necessities (Sharif and Farooq, 2004; Farooq *et al.,* 1999). In spite of tremendous potential, Pakistan has not had the capacity to exploit its huge animal's populace to turn into a noteworthy part in the worldwide meat market (Anonymous, 2006). Furthermore, Pakistan also exports live animals to various countries as a result of US$ 13.95 earnings from their export (Anonymous, 2009-10).

Livestock sector plays a vital role in agriculture. About 35 million individuals are occupied with this area which pays almost 11% to the GDP (Simon, 1980). Moreover, in order to enhance the advancement of agriculture, it is very important for the Pakistani government to extend its concentration including livestock and dairy products. Meat is a most important product which is a major source of high nutrients, proteins and fibre content; and it is deliberated as a fundamental human nourishment. Due to the traditional method, the growing demand for production of red meat does not meet the requirements, and there are no inducements for the producers to offer quality meat because of the old traditions. Issues are because of improper facilities, old-styled slaughter houses and the delivery of meat with no price structure (Iqbal *et al.,* 2000).

Sanders and Manfredo (2002) forecasted the production of pork, red meat and broilers in the United States Department of Agriculture (USDA). Moreover, Hossain and Hassan (2013) forecasted the yield of milk, meat and egg in Bangladesh. Livestock plays a significant role in the nation's economy of Bangladesh. Keeping this in mind, this study was used to find the well fitted deterministic type growth model by utilizing modern model selection criteria that can be further used to access the growth pattern of meat milk and egg production in Bangladesh during 1991-92 to 2011-12. They concluded that the cubic model is the best fitted model that can be further used for forecasting purposes. Results showed that the yield of milk, meat and egg would be 4.55, 3.77 and 7544.6 million tons, correspondingly, in 2015-16. Furthermore, Bashir *et al. (*2015) also showed the economics of the production of red meat in Punjab.

Akgül and Yildiz (2016) forecasted a red meat production and policy recommendations in Turkey. They used the Box-Jenkins methodology to estimate and forecasted the consumption of red meat. Randhawa *et al.* (2018) demonstrated a growth performance of meat production from 1997-95 to 2016-17 and export in Pakistan. They showed that growth of three types of meat i.e., poultry, mutton and red meat is decreasing over time. In the duration of 1997-98, the growth performance of poultry showed decline trends while mutton and red meat in 2005-06 and1995-96 showed a negative growth rate respectively. Dostain *et al.* (2018) have done time series analysis related to livestock management, a case study of Baluchistan, Pakistan. Researchers forecasted the production of red meat in Baluchistan. Box-Jenkins ARIMA models and regression models where years are taken as an explanatory variable were utilized in order to assess the production of red meat. Based on this model, five years ahead forecast are made to tackle all the upcoming scenarios. The present literature showed that no research work is done on the production of red meat. So, the objective of this study is to forecast the red meat production in Pakistan using appropriate time series model which me*et al*l pertinent assumptions.

MATERIALS AND METHODS

Pakistan is the 6th most populous country in the world with an area of 796,095 sq. km. and about 44% of the total land mass covered by the Pakistan. In this section, research methodology and research design are explained. The purpose of this study is to forecast the six years production of red meat in Pakistan based on 1996-2019 data to tackle all the upcoming emergencies. The data on the production of red meat have been collected from different data collecting organizations i.e., Food and Agricultural Organization (FAO), Index Mundi and Pakistan Bureau of Statistics (PBS). Various time series models are used in different studies to assess the best fitted model in all perspectives. This examination depicts a pragmatic investigation of modelling and forecasting the future production of red meat. The Box and Jenkins (1976) methodology were utilized to consider the production of red meat. Literature showed that the time series models are the important models which are widely used for forecasting purposes. Moreover, these forecasted values are helpful for the policy makers to meet the challenges in advance. As these models are also used to forecast econometric time series (Brown, 1974; Holt *et al.,* 1960). Some forecasting models with mathematical forms are given in Table 2 (Gujarati and Porter, 2008; Tsay, 2005).

Table 2. Some time series models.

Sr. No	Model Name	Equation of Model
i	Random Walk	$Y_t = b\,Y_{t-1} + e_t$
ii	Random Walk with Drift	$Y_t = a + b\,Y_{t-1} + e_t$
iii	Linear Trend	$Y_t = a + b\ + e_t$
iv	Quadratic Trend	$Y_t = a + b\ + ct^2 + e_t$
v	Exponential Trend	$Y_t = \exp(a + b\ ) + e_t$
vi	S-Curve Trend	$Y_t = \exp\left(a + \frac{b}{t}\right) + e_t$
vii	Moving Average (2)	$Y_t = a + e_t + b_1 e_{t-1} + b_2 e_{t-2}$
viii	Simple exponential smoothing	$Y_t = \lambda Y_t + (1-\lambda) Y_{t-1} + e_t$

To select the suitable model, the most conventional method has been utilized which is particularly named as the best model selection criteria. In this study, three most important criterions termed as Akaike Information Criteria (AIC), Schwarz Bayesian Information Criteria (SBIC) and Root Mean Squared Error (RMSE) which are particularly used (Amin *et al*., 2014). These criterions are mathematically defined by

$$A = -2\{\log(\text{Likelihood}) + k\};$$

$$S = -2\{\log(\text{Likelihood}) + k\log(n)\};$$

$$R = \sqrt{\frac{\sum_{t=1}^{n}(Y_t - \hat{Y}_t)^2}{n-k}},$$

where k represents the number of unknown parameters of the considered time series model, n represents the total number of observations, Y_t represents the actual time series data and $\hat{Y}_t$ represents the predicted value for time t period. The most appropriate model is that which have minimum AIC and SBIC among others (Tsay, 2005). On the basis of these criterions, we select the best fitted model which is further used for forecasting red meat of Pakistan.

RESULTS AND DISCUSSION

The basic objective of this paper is to forecast the production of red meat in Pakistan. For this aim, we fit various time series models. The reason for fitting multiple time series models is to acquire a reliable forecast based on the statistical measures.

Time series model fitting of red meat production for the year 1996-2019 are presented in Table 3. Table 3 displayed the various time series models with model selection criteria are fitted to choose the suitable model in the entire class.

Furthermore, the best model is chosen on the basis of RMSE, AIC and SBIC. Results demonstrated that the best model is the model *(ii)* i.e., Random walk model with drift. In this model, drift= 97.9565 which indicated that if the red meat production does not depend on previous one year's red meat production, then the estimated red meat production would be 97.9565 thousand metric tons. We called this model as a most fitted due to its minimum RMSE, AIC and SBIC values. So, this model is further utilized to forecast the production of red meat in Pakistan.

Testing Fitted Model Assumptions: For reliable forecasted values of red meat production, it is necessary that the fitted model fulfil the assumptions such as no autocorrelation, normality and homoscedasticity of the fitted model residuals. Now we test some assumptions of the best fitted (random walk) model. For this purpose, first we test the stationarity of the time series data which is tested with the help of Augmented Dickey Fuller (ADF) test. The test statistic (p-value) of the ADF test found to be -0.3459 (0.9025) indicated the series is

stationary. Next, we test the homoscedasticity of the fitted model errors using the most popular White test. The test statistic (p-value) of the White test found to be 0.6081(0.5541) which indicated that the residuals of the random walk model with drift are homoscedastic. To test the autocorrelation among the residuals of the best fitted model, we use the Breusch-Godfrey LM test. The test statistic (p-value) of the Breusch-Godfrey LM test for the random walk with drift found to be 0.1320 (0.9940) which indicated that the fitted model residuals are uncorrelated. Moreover, we also used the Durbin Watson test to test the autocorrelation. The computed value of the test statistic found to be 1.996 (approximately closed to 2). If the Durbin Watson d=2, then this indicated that the residuals of the fitted model are uncorrelated (Gujarati and Porter, 2008). Hence both methods i.e. Breusch-Godfrey LM test and Durbin Watson confirm that the estimated residuals of the best fitted model are uncorrelated. The normality is also tested with the help of periodogram which is shown in Fig 3. Furthermore, Fig 3 showed that the residuals of random walk model with drift are normally distributed.

Table 3: Best Model Selection Criteria for Forecasting Red Meat Production.

Model	*RMSE*	*AIC*	*SBIC*
(i)	74.108	8.611	8.611
(ii)	57.769	8.196	8.245
(iv)	73.305	8.756	8.854
(v)	74.883	8.882	9.029
(vi)	95.325	9.281	9.379
(vii)	281.754	11.449	11.547
(viii)	95.699	9.206	9.255
(ix)	74.111	8.694	8.744
(x)	69.130	8.555	8.604
(xi)	59.293	8.332	8.430

Models
(i) Random Walk (ii) Random walk with drift = 47.9565 (iii) Linear trend = 639.025 + 52.7413 t (iv) Quadratic trend = 627.865 + 55.3167 t + -0.103018 t^2 (v) Exponential trend = exp(6.59168 + 0.0426379 t) (vi) S-curve trend = exp(7.28566 + -1.02337 /t) (vii) Simple moving average of 2 terms (viii) Simple exponential smoothing with alpha = 0.9999 (ix) Brown's linear exp. smoothing with alpha = 0.5567 (x) Holt's linear exp. smoothing with alpha = 0.9741 and beta = 0.0424 (xi) Brown's quadratic exp. smoothing with alpha = 0.3362

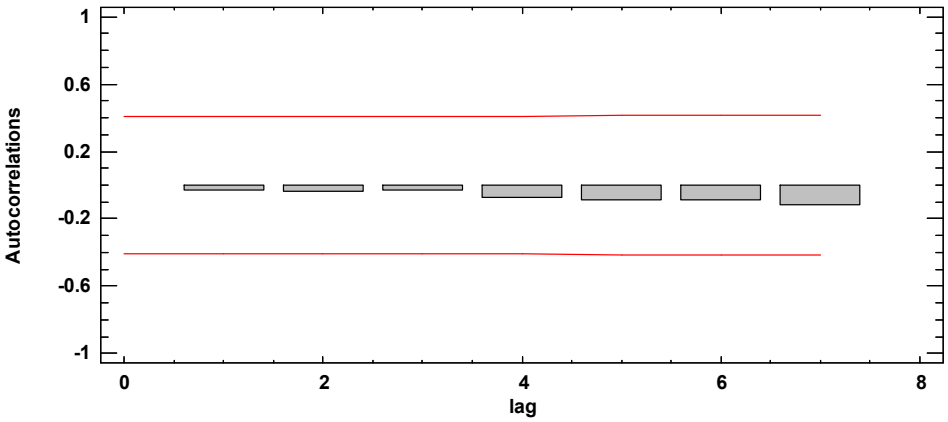

Fig 1: Autocorrelation Plot of Red Meat Production for Residuals of the Random Walk Model with Drift.

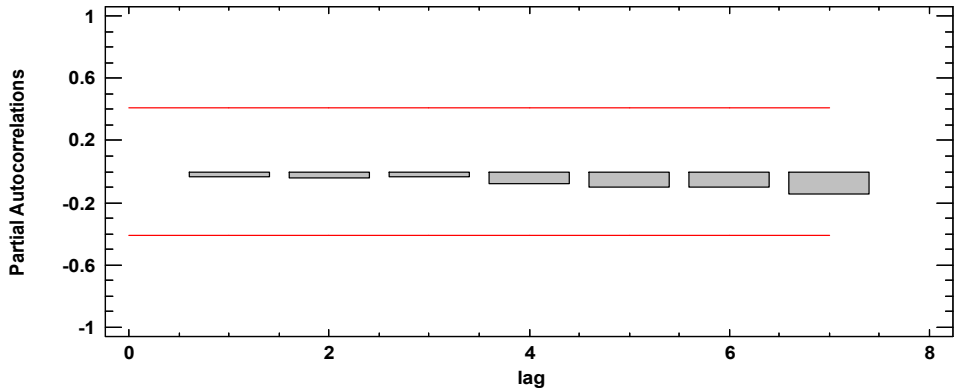

Fig 2: Partial Autocorrelation Plot of Red Meat Production for the Residuals of the Random Walk Model with Drift.

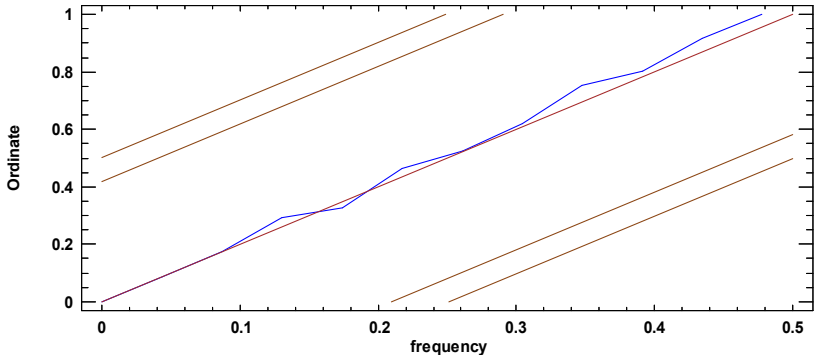

Fig 3: Periodogram of Residuals for Red Meat Production for Random Walk Model with Drift.

Table 4: Annual Forecasting of Red Meat Production in Pakistan.

Period	*Forecasted*	*95.0% Lower Confidence Limit*	*95.0% Lower Confidence Limit*
2020	1867.96	1748.15	1987.76
2021	1915.91	1746.48	2085.34
2022	1963.87	1756.36	2171.38
2023	2011.83	1772.22	2251.44
2024	2059.78	1791.89	2327.68
2025	2107.74	1814.28	2401.2

Red meat production forecasted values on the basis of random walk model with drift for the next 6 years i.e., from 2020-25 are shown in Table 4. Graphical representation of actual and forecasted values is also shown in Fig 4.

Furthermore, we have found that red meat production of Pakistan would become 1867.96 thousand metric tons with lower and higher production may be expected to be 1784.15 and 1987.76 respectively in 2020. On the other hand, the production of red meat for the year 2025 is expected to be 2107.74 thousand metric tons with minimum and maximum production value expected to be 1814.28 and 2401.2 respectively.

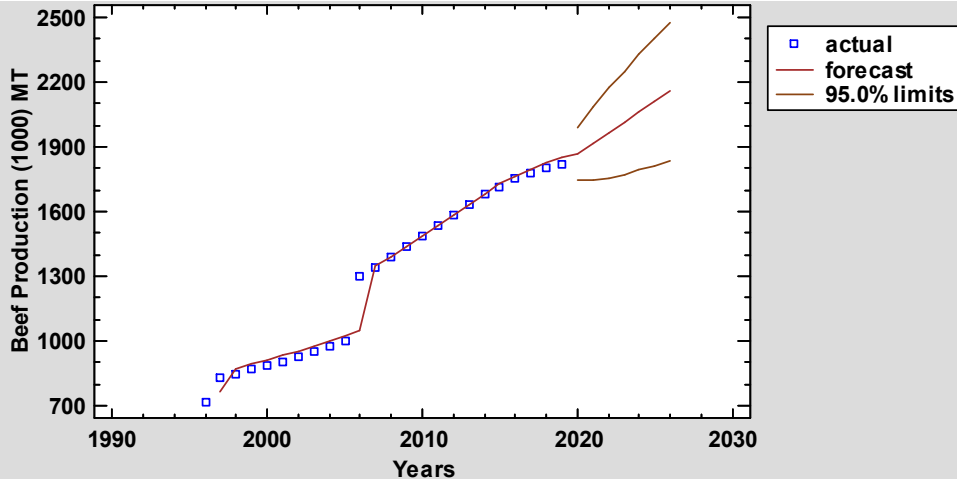

Fig 4: Forecasted Values of Red Meat Production in Pakistan

Livestock being the important part of agriculture that plays a crucial role in the lives of farmers especially in developing countries like Pakistan. This part not just guarantees food security but also responsible for raising the country's GDP. Due to its matchless proximity, Pakistan has a vast livestock population. That's the reason Pakistan has standing among the 4th biggest animal herd in the whole world; 180 million animals growing at the rate of 4.2 percent yearly (Randhawa *et al.,* 2018). Different discussions on the production of meat including red meat, mutton and poultry are

presented in the literature. Some of which are discussed here.

Jamal *et al.* (2010) analysed the performance of the red meat production in Pakistan from 1994-95 to 2016-17. They noticed that due to Foot-and-Mouth Disease Virus (FMDV) resulting a negative annual growth rate of -0.035 in 1995-96 in large ruminants which affects the red meat production severely. Moreover, from 1996-97 to 2004-05 the growth rate still showed a decline trend i.e., 0.023 to 0.026 because of recurrence of FMDV. A recent study related to the growth performance of meat production and export in Pakistan by Randhawa *et al.* (2018). The study focused on the growth performance and export of meat production from 1994-95 to 2016-17 in Pakistan. Results showed that the production of red meat exhibit negative growth in 1995-96. Mutton also shown decline trend due to negative growth rate in 1995-96 and 2005-06. They also showed that over the time there is a rapid increase in the growth rate both in red meat and mutton which automatically enhance the production of both types of meat. Same results are shown in our study.

Thornton (2010) gave the recent trends and its future prospects of livestock production. Due to the increasing demand of livestock products in developing countries, many production systems focused to increase their efficiency and environmental sustainability. Advances in breeding, health of animals and nutritional level may enhance the production. Furthermore, Tey *et al.* (2008) investigated the preference related to red meat quality, quantity or lean for Malaysian consumers. Two-stage least squares are utilized to access the demand and prices of consumers. Findings of the result showed that the consumers want quantity rather than quality of the red meat products. It is also better for the red meat marketers to enhance the production of red meat as Malaysian people consume more amount to purchase red meat products. Almost four decades ago, Malaysia has improved the red meat cattle industry. The breeding system in Malaysia is very poor. Inadequate breed-able cattle's put the Malaysian economy down. Precautionary steps to increase the fertility rate in the cattle's and restriction of slaughtering the female cows may contribute a significant effect in the production of red meat (Jamaludin *et al.*, 2014). So, we determine from the above discussion that all the results conversed above are consistent with our findings.

Conclusion: The best fitted model meets the requirements of model selection criteria i.e., minimum AIC and SBIC. Furthermore, one should also notice that the fitted model also fulfils the assumptions of normality, no autocorrelation and independence. On the basis of model selection criteria, we have found that for forecasting of red meat production in Pakistan the best time series model is the random walk model with drift. Based on the most suitable model, we annually forecast red meat production from 2020-25 which shows that as time period goes on the production gradually increases keeping all factors held constant. Moreover, the production of red meat in Pakistan may expect to be increasing 15.81% in the year 2025 in contrast to 2019.

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