Prediction of Marbling Scores From Percentage Intramuscular Fat

A.S. Leaflet R1434

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Summary

In this study two separate sets of data were used to develop prediction equations for Marbling Scores (MS) from actual percentage intramuscular fat. All regression parameters were significantly (P<.01) different from zero. Model-I explained only 49% of the variation in MS as compared with 83% for model- II. When these equations were validated on an independent data set, the correlations between the predicted and actual marbling scores were similar at 0.69 and 0.66 for model-I and model-II, respectively. Model-I has correctly classified 45.45%, 67.62%, 63.83%, and 42.86% of the bservations in trace, slight, small and modest classes, respectively. Model-II performed better than model-I for the extreme MS classes (practically devoid and moderate).

Introduction

In today's value-based marketing system both quantity and quality of beef carcasses determine profitability. Since marbling or intramuscular fat represent the dominant factor in USDA quality grade, a constant monitoring of the trait in live feedlot cattle helps produce a uniform and quality end product. The objective of this study was to develop models for the prediction of Marbling Scores (MS) from actual Percentage of Intramuscular Fat (PIMF) data.

Materials and Methods

Source of data

Data collected from feedlot cattle at Rhodes and McNay research farms were used to study the relationship between marbling scores and chemically extracted percentage of intramuscular fat. Cattle were progeny of synthetic, Angus, and Simmental sires.

Each year chilled carcasses were ribbed and MS were determined by a USDA grader to the nearest tenth of a degree (slight^{0}, slight^{10}, .. slight^{90}, small^{0} , etc.). Actual percentage intramuscular fat was determined from a meat sample taken from the 12-13th rib of the carcasses using n-hexane chemical extraction.

Data analysis

After editing and preliminary evaluation of observations, prediction equations were developed using regression procedures of SAS (1989). In the validation step, accuracy of prediction was evaluated using correlation coefficients and by comparing the frequency of correctly classified predicted observations in each of the grader-classified MS classes.

Results

Model development

Means and standard deviations of observations used in the development and validation of prediction models is shown in Table 1. Indicated in the same table are correlations between MS and PIMF. In the model development stage two sets of data were used. Set-I included observations collected over five years (1991-95), and set-II came from 44 feedlot cattle used in a 1996 ultrasound technician certification session held at ISU. The mean MS in the two data sets used in the development of prediction models were similar, but observations in set-II showed a higher variation and a stronger linear association with PIMF than those in set-I. Animals used for certification were intentionally selected to represent low, medium and high degrees of fatness thus resulting in a higher variance of observations. Furthermore, under this kind of sampling a grader may be able to rank cattle more easily than under actual feedlot conditions.

Results of regression analysis are depicted in Table 2. All regression parameters were significantly (P < .01) different from zero. However, model-I (model developed from data set-I) explained only 49% of the variation in MS compared with 83% for model-II (model developed from data set-II).

Model validation

The correlations between the predicted and actual MS were similar at 0.69 and 0.66 for models I and II, respectively.

The frequency of observations classified into the different marbling score classes by the two models is shown in Table 3. The majority of the cattle used for validation had MS values of SL (slight^{0} to slight^{90}) and very few data were available to test for prediction of extreme MS classes. The diagonal values show the percentages of data within the respective classes that were correctly classified by the prediction models. For instance, of the five observations in the grader-classified PD (Practically Devoid) class, model-I classified 60% of them in the TR (Trace) class and the rest in the SL class. None were classified in the PD class. However, model-II was able to place 40% of the observations correctly. Model-I has correctly classified 45.45%, 67.62%, 63.83%, and 42.86% of the observations in TR, SL, SM (Small), and MT (Modest) classes, respectively. Model-

II performed better than model-I in classifying PD and MD (Moderate), but seems less accurate than model-II in the intermediate classes.

MS is a very subjective measure. In the initial evaluation of scatter diagrams (not shown here), we learned that a particular marbling score class contains a wide ranges of PIMF values. For instance, a MS of Small ($Small^0$ to $Small^{90}$) contained PIMF values ranging from 2% to 10.4%. Furthermore, evaluations of the relationship between MS and PIMF by year and slaughter group were not consistent. Therefore, the disparity between predicted and grader-classified MS may not be surprising. The relationship between the predicted MS and PIMF for model-I and model-II is shown in Figure 1.

Besides MS and PIMF, our data file also contained ultrasound-predicted percentage intramuscular fat (UIMF). However, the regression of MS on UIMF showed the same accuracy of prediction during validation. Therefore, with some caution model-I may be used to predict MS in live cattle based on ultrasound predicted percentage intramuscular fat.

Implications

Marbling Scores (MS) could be predicted from ultrasound-predicted percentage intramuscular fat (UIMF) measures of live cattle. However, the subjective nature of MS values needs to be understood, and perhaps future work in redefining and use of fewer and broader MS classes may partly correct the problem.

References

SAS institute Inc. 1989. SAS/STAT® User's Guide, Version 6, 4th ed, vol. 2, Cray, NC.

Table 1. Means, standard deviations and correlations of observations used in model development and validation.

	Mean ±sd		Correlations (MS and PIMF)	
Data type	Marbling scores*	PIFAT	Pearson	Spearman
Development				
Set-I	1023± 96	4.91 ±2.01	.69	.71
(n)	(880)	(880)		
Set-II	1010±138	4.31± 1.90	.90	.91
(n)	(44)	(44)		
Validation	954± 82	3.87±1.72	.70	.67
(n)	(200)	(200)		

* Marbling scores: Practically devoid = 700, Trace = 800, Slight = 900, Small = 1000, Modest = 1100, Moderate = 1200. n = number of observations

Table 2. Regression analysis results.

	Regression parameters*		
	Intercept±sd	L±sd	Q±sd
Data set-I	811.83±13.05	52.91±4.84	-1.742±.41
	RMSE = 68.69	*R^2 = .49*	
Data set-II	653.47±44.45	112.94±20.35	-5.05±2.11
	RMSE = 57.56	*R^2 = .83*	

* L = linear effect of PIMF Q = Quadratic effect of PIMF

Table 3. Percentages of observations classified into the different marbling score classes based on predicted values.

Grader Marbling Scores(n)*		Predicted marbling score classes PD	TR	SL	SM	MT	MD
PD(5)	model-I	0	60	40	0	0	0
	model-II	40	60	0	0	0	0
TR(33)	model-I	0	45.45	42.42	12.13	0	0
	model-II	30.30	45.45	12.12	3.03	9.09	0
SL(105)	model-I	0	3.81	67.62	27.62	0.95	0
	model-II	2.86	20.00	38.09	30.48	7.62	.95
SM(47)	model-I	0	0	29.79	63.83	6.38	0
	model-II	0	2.12	14.89	46.81	29.79	6.38
MT(7)	model-I	0	0	0	57.14	42.86	0
	model-II	0	0	0	14.29	28.57	57.14
MD(3)	model-I	0	0	0	33.33	66.67	0
	model-II	0	0	0	0	33.33	66.67

* Marbling scores: practically devoid(PD) = 700, Trace(TR) = 800, Slight(SL) = 900, Small(SM) = 1000, Modest(MT) = 1100, Moderate (MD)= 1200. n = number of observation per class in USDA grader classified classes

Table 4. Relationship between the USDA quality grade, degrees of marbling and PIMF*

Carcass Quality	Marbling	PIMF
Prime	Slightly abundant	8.96
Choice	Moderate	7.14
	Modest	7.02
	Small	5.16
Select	Slight	3.72
Standard	Traces	2.54

* Data set-I

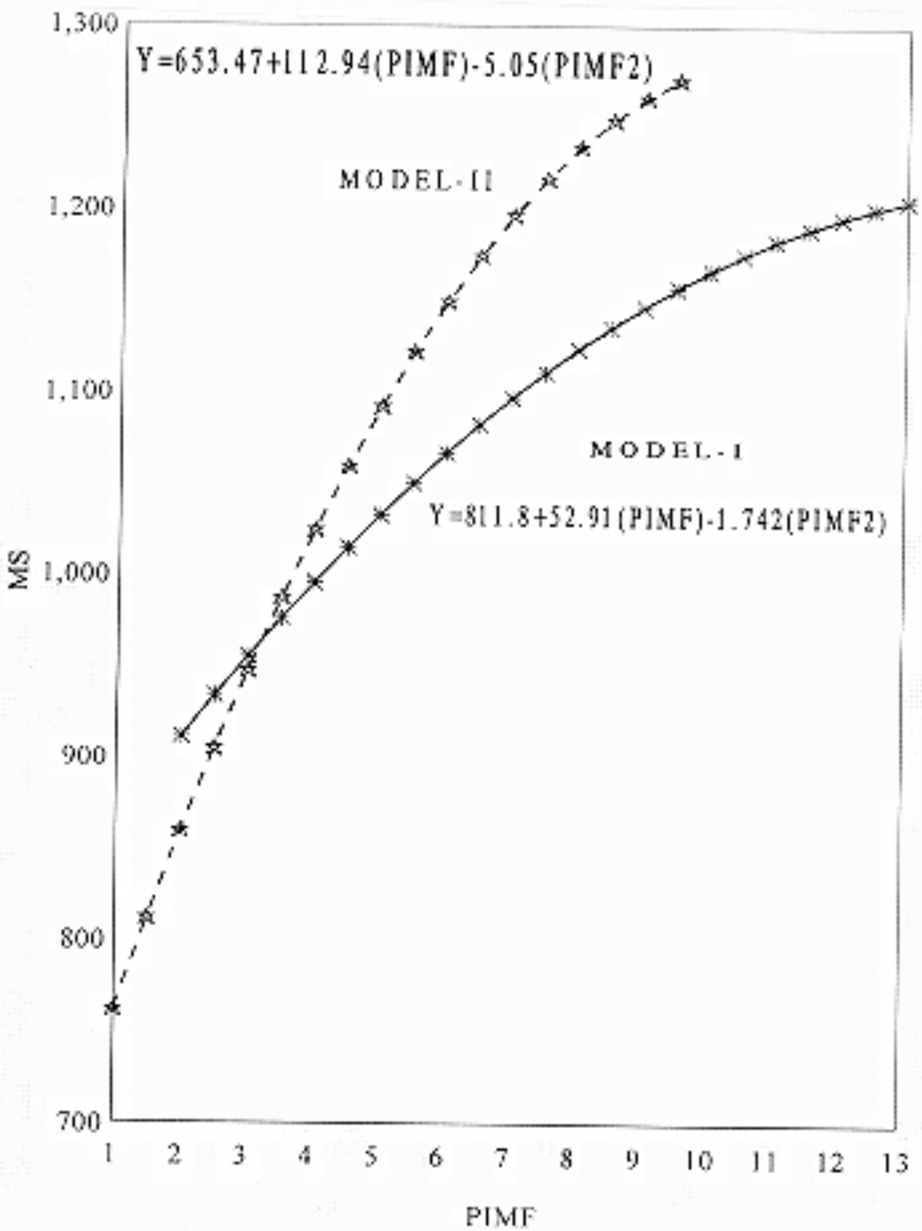

Figure 1. The relationship between MS and PIMF values.