The SAS System
PROC FASTCLUS Analysis Using LEAST= Clustering Criterion
Values < 2 Reduce Effect of Outliers on Cluster Centers
The FASTCLUS Procedure
Replace=FULL Radius=0 Maxclusters=4 Maxiter=1

Initial Seeds							
Cluster	**SCORE**	**Altitude_m**	**P_Hum_Alm**	**HULLING_ LOSS**	**H_Beans**	**Factor_Milling**	**AW_Alm**
1	-0.146990071	0.125322572	-0.265586404	1.292899403	-3.061585786	3.173747817	0.238660113
2	-0.265580635	-1.588435720	0.498041791	-0.370659686	0.332353675	-0.323933878	0.565459218
3	0.528793388	-0.146426792	-0.508940444	-1.602852477	1.164011481	-0.992858494	-0.559677917
4	-0.554993964	-0.636918106	0.756412233	-0.322102922	0.529494740	-0.495767272	-0.220518604

Initial Seeds							
Cluster	**B_size_greater_ 16**	**B_size_minus_ 16**	**Lipids**	**CQAT**	**Sucruse**	**Cafeine**	**Trigoneline**
1	-1.162117521	1.162007792	0.129246200	0.152276954	0.623688072	-0.724124896	0.533790885
2	-2.230656629	2.230538426	-1.396606925	-0.165561545	0.685812889	-0.173982128	1.160925272
3	0.796589915	-0.795672995	0.192316937	-0.820893714	-1.300373580	2.025029835	0.582898599
4	0.608636070	-0.608731754	-0.641170058	0.277718494	1.220838308	-0.516735550	1.516426601

Initial Seeds							
Cluster	**Palmitic**	**Linoleic**	**Oleic**	**Estearic**	**Araquidic**	**prec_prom_anual**	**tmean_prom_anual**
1	-0.316044568	-0.469988846	-0.010028466	0.931828872	-0.022375038	0.003997734	0.055940641
2	-2.378100275	-0.497027538	0.032933324	1.803540020	1.721630796	0.261047721	1.746868882
3	-0.579381624	1.399127810	-0.994389697	-0.996680143	1.243307824	-0.338149288	-0.437255989
4	-0.385107628	-0.062048224	0.360091407	0.553992664	-0.776393801	2.061832558	0.322794007

Criterion Based on Final Seeds =	0.8891

Cluster Summary						
Cluster	Frequency	RMS Std Deviation	Maximum Distance from Seed to Observation	Radius Exceeded	Nearest Cluster	Distance Between Cluster Centroids
1	186	0.9697	11.6757		4	3.7077
2	146	0.9823	9.6734		4	3.6570
3	339	0.8604	7.1552		4	2.7755
4	437	0.8289	7.2035		3	2.7755

Statistics for Variables				
Variable	Total STD	Within STD	R-Square	RSQ/(1-RSQ)
SCORE	1.00000	0.98455	0.033293	0.034440
Altitude_m	1.00000	0.89780	0.196148	0.244010
P_Hum_Alm	1.00000	0.96884	0.063908	0.068271
HULLING_LOSS	1.00000	0.89033	0.209465	0.264965
H_Beans	1.00000	0.72613	0.474161	0.901723
Factor_Milling	1.00000	0.74589	0.445159	0.802317
AW_Alm	1.00000	0.98752	0.027443	0.028217
B_size_greater_16	1.00000	0.80852	0.348067	0.533900
B_size_minus_16	1.00000	0.80852	0.348061	0.533885
Lipids	1.00000	0.95511	0.090232	0.099181
CQAT	1.00000	0.92130	0.153498	0.181332
Sucruse	1.00000	0.95303	0.094199	0.103995
Cafeine	1.00000	0.84685	0.284790	0.398191
Trigoneline	1.00000	0.96184	0.077377	0.083866
Palmitic	1.00000	0.90129	0.189883	0.234390
Linoleic	1.00000	0.79375	0.371668	0.591515
Oleic	1.00000	0.86836	0.247998	0.329783
Estearic	1.00000	0.75701	0.428495	0.749765
Araquidic	1.00000	0.88963	0.210698	0.266943
prec_prom_anual	1.00000	0.94410	0.111097	0.124982
tmean_prom_anual	1.00000	0.89009	0.209895	0.265655
OVER-ALL	1.00000	0.88448	0.219822	0.281759

Pseudo F Statistic =	103.69

Approximate Expected Over-All R-Squared =	0.09078

Cubic Clustering Criterion =	109.626

WARNING: The two values above are invalid for correlated variables.

Cluster Means							
Cluster	**SCORE**	**Altitude_m**	**P_Hum_Alm**	**HULLING_ LOSS**	**H_Beans**	**Factor_Milling**	**AW_Alm**
1	-0.305981824	0.179922086	-0.363656045	0.979931989	-1.503669499	1.462978743	-0.218511019
2	-0.147769182	-0.933802078	0.094559183	0.023631737	-0.031681947	-0.007483352	0.124194663
3	0.218671851	0.473975969	-0.191559396	-0.118840481	0.374087931	-0.356313562	-0.147174293
4	0.009970623	-0.132284344	0.272160690	-0.332793273	0.360394239	-0.343778442	0.165181243

Cluster Means							
Cluster	**B_size_greater_ 16**	**B_size_minus_ 16**	**Lipids**	**CQAT**	**Sucruse**	**Cafeine**	**Trigoneline**
1	-0.821540624	0.821520574	0.569890349	0.129802119	-0.029293731	-0.260694996	0.257594941
2	-0.996131682	0.996142981	-0.236303066	-0.345800712	0.380395625	-0.328107381	0.570443600
3	0.405782788	-0.405673854	0.110579088	-0.462620629	-0.428546052	0.800022966	-0.091482470
4	0.367692029	-0.367771775	-0.249395122	0.419158130	0.217821474	-0.400033956	-0.229255990

Cluster Means							
Cluster	**Palmitic**	**Linoleic**	**Oleic**	**Estearic**	**Araquidic**	**prec_prom_anual**	**tmean_prom_anual**
1	0.195208380	-0.343223075	0.020881535	0.404439411	-0.105743122	-0.200538161	-0.067745037
2	-1.117626835	-0.639445326	0.058245691	1.358127555	1.056974643	0.780261676	0.953985442
3	0.166481249	0.906142252	-0.690327583	-0.712928367	0.098945091	-0.276643875	-0.523089725
4	0.161161592	-0.343212160	0.507169827	-0.072836698	-0.384879778	0.039277269	0.115895010

Cluster Standard Deviations							
Cluster	**SCORE**	**Altitude_m**	**P_Hum_Alm**	**HULLING_ LOSS**	**H_Beans**	**Factor_Milling**	**AW_Alm**
1	1.008488469	0.851656421	1.008884279	0.959141762	1.159309079	1.424473217	1.105757781
2	1.015952200	1.009519443	0.935198853	0.884789861	0.654021699	0.573148086	0.960430652
3	0.933075013	0.735088168	1.086952503	0.878132107	0.580512233	0.486988701	1.118255774
4	1.002353339	0.987614416	0.859239199	0.871017278	0.601102176	0.504633687	0.821517006

Cluster Standard Deviations							
Cluster	**B_size_greater_ 16**	**B_size_minus_ 16**	**Lipids**	**CQAT**	**Sucruse**	**Cafeine**	**Trigoneline**
1	0.994188998	0.994190957	0.840892858	1.031319060	0.908804188	0.859056447	1.016254340
2	1.178295088	1.178047065	1.261304638	0.990978990	0.909738438	0.977358670	0.988396385
3	0.703955702	0.704122027	0.871166016	0.925934982	0.979114293	0.890200313	0.981782124
4	0.624465574	0.624487683	0.944688934	0.840661350	0.964854683	0.755488496	0.912237445

Cluster Standard Deviations							
Cluster	**Palmitic**	**Linoleic**	**Oleic**	**Estearic**	**Araquidic**	**prec_prom_anual**	**tmean_prom_anual**
1	0.945432981	0.848216167	0.795155992	0.826685912	0.844570697	0.758817928	0.953961371
2	0.922645103	0.945037012	1.043519575	0.861182217	0.879824707	1.325459817	0.813582652
3	0.881952468	0.785354292	0.921695798	0.736191023	1.064268808	0.663812022	0.822308614
4	0.889662108	0.717556469	0.787607690	0.703041018	0.752231294	1.042459557	0.935729670

Total Sample Size	1103	**DF Total**	1102
Variables	21	**DF Within Classes**	1099
Classes	4	**DF Between Classes**	3

Number of Observations Read	1108
Number of Observations Used	1103

Class Level Information				
CLUSTER	Variable Name	Frequency	Weight	Proportion
1	_1	185	185.0000	0.167724
2	_2	146	146.0000	0.132366
3	_3	337	337.0000	0.305530
4	_4	435	435.0000	0.394379

Multivariate Statistics and F Approximations					
S=3 M=8.5 N=538.5					
Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.11464075	54.51	63	3221.6	<.0001
Pillai's Trace	1.49869030	51.39	63	3243	<.0001
Hotelling-Lawley Trace	3.36684251	57.60	63	2794.9	<.0001
Roy's Greatest Root	1.81877182	93.62	21	1081	<.0001
NOTE: F Statistic for Roy's Greatest Root is an upper bound.					

	Canonical Correlation	Adjusted Canonical Correlation	Approximate Standard Error	Squared Canonical Correlation	Eigenvalues of Inv(E)*H = CanRsq/(1-CanRsq)			
					Eigenvalue	Difference	Proportion	Cumulative
1	0.803266	0.798322	0.010687	0.645236	1.8188	0.8153	0.5402	0.5402
2	0.707713	0.701502	0.015036	0.500858	1.0034	0.4588	0.2980	0.8382
3	0.593798	0.586666	0.019502	0.352596	0.5446		0.1618	1.0000

	Test of H0: The canonical correlations in the current row and all that follow are zero				
	Likelihood Ratio	Approximate F Value	Num DF	Den DF	Pr > F
1	0.11464075	54.51	63	3221.6	<.0001
2	0.32314612	40.99	40	2160	<.0001
3	0.64740356	30.99	19	1081	<.0001

Total Canonical Structure			
Variable	**Can1**	**Can2**	**Can3**
SCORE	0.205659	0.088511	-0.072976
Altitude_m	0.452859	-0.330263	0.165674
P_Hum_Alm	-0.057674	0.330211	0.130649
HULLING_LOSS	-0.245202	-0.579533	0.016464
H_Beans	0.471490	0.796234	-0.187376
Factor_Milling	-0.444847	-0.777587	0.199179
AW_Alm	-0.062868	0.214559	0.059475
B_size_greater_16	0.621763	0.361277	0.324061
B_size_minus_16	-0.621710	-0.361328	-0.324155
Lipids	0.010385	-0.424968	0.013663
CQAT	-0.166951	0.161263	0.589797
Sucruse	-0.310333	0.228866	0.128684
Cafeine	0.540400	-0.227989	-0.450877
Trigoneline	-0.242032	-0.138590	-0.288915
Palmitic	0.336227	-0.184658	0.536230
Linoleic	0.689726	-0.217736	-0.343989
Oleic	-0.365759	0.340468	0.540593
Estearic	-0.790036	0.058380	-0.261671
Araquidic	-0.209244	-0.016376	-0.723671
prec_prom_anual	-0.314977	0.249772	-0.243142
tmean_prom_anual	-0.503234	0.281550	-0.142860

CAN1: Represents a gradient that combines bean size, fatty acids, and environment.
CAN2: Reflects differences in the physiological state of the bean, its health, and the efficiency of the process.

Based on the above, cluster 3 consists of samples from higher altitudes, with larger bean size and a favorable lipid profile (linoleic acid). In contrast, cluster 2 samples are characterized by being from lower altitudes, with higher temperatures, and higher stearic acid levels.

Cluster 1 is characterized by samples of lower physical quality with high percentages of losses and a low yield factor; that is, a low physical quality and low productivity profile. Cluster 4 is associated with samples of good physical quality and a good yield factor.

The identified groups represent distinct coffee profiles that integrate physical, chemical, and environmental attributes. The strong influence of bean size and lipid composition highlights their relevance in differentiating quality classes, while variables such as altitude and temperature contribute to structuring these profiles.

Between Canonical Structure			
Variable	**Can1**	**Can2**	**Can3**
SCORE	0.908122	0.344342	-0.238207
Altitude_m	0.820337	-0.527094	0.221853
P_Hum_Alm	-0.184898	0.932707	0.309629
HULLING_LOSS	-0.432799	-0.901234	0.021482
H_Beans	0.550475	0.819039	-0.161719
Factor_Milling	-0.535955	-0.825399	0.177394
AW_Alm	-0.308163	0.926602	0.215509
B_size_greater_16	0.841997	0.431046	0.324408
B_size_minus_16	-0.841928	-0.431109	-0.324503
Lipids	0.027716	-0.999252	0.026956
CQAT	-0.342106	0.291144	0.893420
Sucruse	-0.812137	0.527693	0.248945
Cafeine	0.811489	-0.301634	-0.500502
Trigoneline	-0.701312	-0.353808	-0.618855
Palmitic	0.617322	-0.298706	0.727797
Linoleic	0.907861	-0.252506	-0.334709
Oleic	-0.590657	0.484412	0.645344
Estearic	-0.969373	0.063111	-0.237345
Araquidic	-0.364152	-0.025109	-0.931001
prec_prom_anual	-0.742526	0.518770	-0.423714
tmean_prom_anual	-0.881470	0.434502	-0.184981

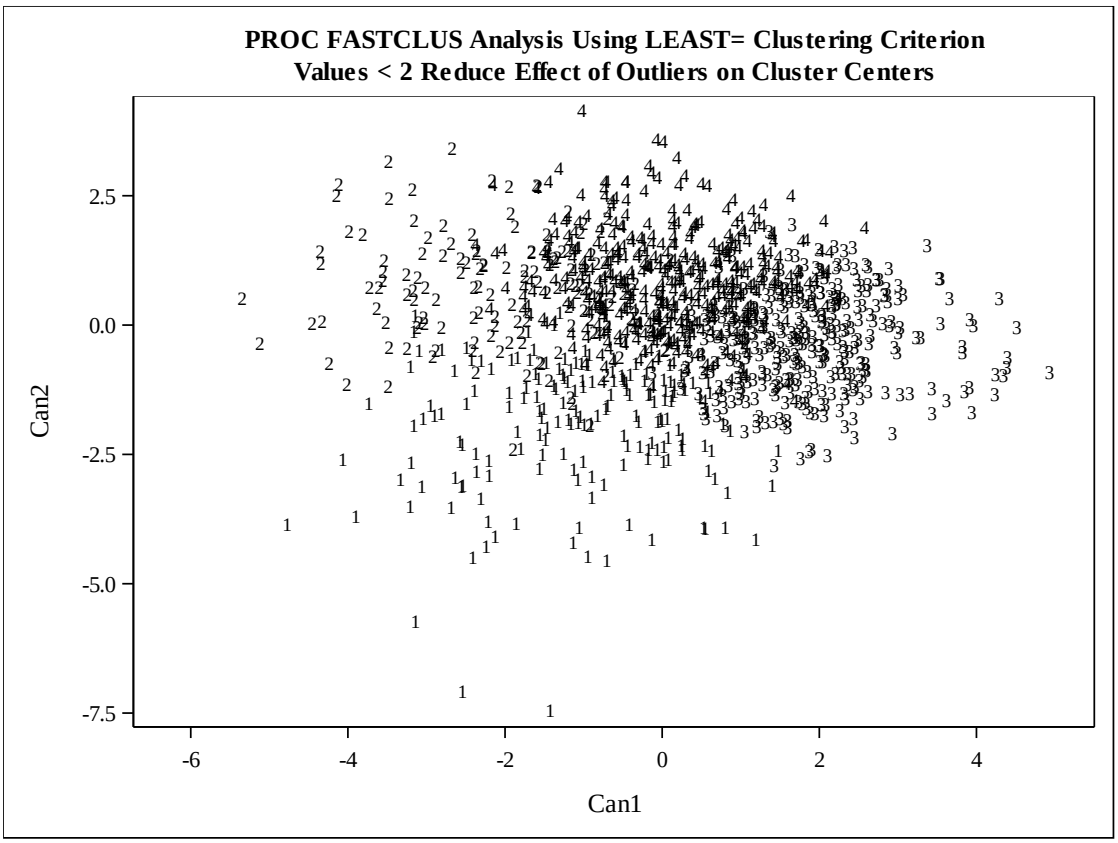
Pooled Within Canonical Structure			
Variable	**Can1**	**Can2**	**Can3**
SCORE	0.124573	0.063594	-0.059713
Altitude_m	0.300937	-0.260325	0.148726
P_Hum_Alm	-0.035483	0.240981	0.108586
HULLING_LOSS	-0.164017	-0.459815	0.014877
H_Beans	0.386976	0.775166	-0.207751
Factor_Milling	-0.355504	-0.737095	0.215027
AW_Alm	-0.037959	0.153663	0.048510
B_size_greater_16	0.459997	0.317038	0.323872
B_size_minus_16	-0.459956	-0.317082	-0.323965
Lipids	0.006486	-0.314839	0.011528
CQAT	-0.108090	0.123844	0.515844
Sucruse	-0.194216	0.169895	0.108792
Cafeine	0.380960	-0.190643	-0.429378
Trigoneline	-0.150040	-0.101908	-0.241948
Palmitic	0.222709	-0.145082	0.479815
Linoleic	0.518575	-0.194181	-0.349380
Oleic	-0.251124	0.277276	0.501397
Estearic	-0.622498	0.054563	-0.278525
Araquidic	-0.140490	-0.013042	-0.656375
prec_prom_anual	-0.199549	0.187696	-0.208088
tmean_prom_anual	-0.337295	0.223840	-0.129350

Total-Sample Standardized Canonical Coefficients			
Variable	**Can1**	**Can2**	**Can3**
SCORE	0.05968879	-0.05733960	-0.04134927
Altitude_m	0.36303693	0.06776912	0.08883397
P_Hum_Alm	-0.03261370	0.12743780	0.17288926
HULLING_LOSS	-0.05819817	-0.16353499	0.06936509
H_Beans	1.01045256	1.13912676	-0.25437556
Factor_Milling	0.72100649	0.04662551	0.11961943
AW_Alm	-0.03742136	0.14593635	-0.06386295
B_size_greater_16	-17.56897149	2.94594488	0.85978853
B_size_minus_16	-18.12310664	2.77401136	0.43894945
Lipids	0.07639443	-0.09643359	0.08191247
CQAT	-0.06225054	0.04074841	0.34446216
Sucruse	-0.16215677	0.15788677	0.15811077
Cafeine	0.33641179	-0.12172503	-0.25410696
Trigoneline	-0.06866834	0.00476928	-0.15291369
Palmitic	0.13541901	-0.15911933	0.15745668
Linoleic	0.29570551	-0.15187033	-0.09340666
Oleic	-0.17718657	0.17096044	0.26108411
Estearic	-0.50663655	0.27192580	-0.07790702
Araquidic	0.03880472	-0.13302294	-0.41415710
prec_prom_anual	-0.13268561	0.20941041	-0.09953791
tmean_prom_anual	0.05158064	0.13591336	-0.07183819

Pooled Within-Class Standardized Canonical Coefficients			
Variable	**Can1**	**Can2**	**Can3**
SCORE	0.05877291	-0.05645977	-0.04071480
Altitude_m	0.32583628	0.06082477	0.07973109
P_Hum_Alm	-0.03161646	0.12354111	0.16760278
HULLING_LOSS	-0.05189297	-0.14581756	0.06185005
H_Beans	0.73428784	0.82779435	-0.18485270
Factor_Milling	0.53810642	0.03479786	0.08927518
AW_Alm	-0.03696582	0.14415983	-0.06308553
B_size_greater_16	-14.16376678	2.37496408	0.69314497
B_size_minus_16	-14.61053512	2.23635998	0.35387345
Lipids	0.07295141	-0.09208742	0.07822075
CQAT	-0.05734645	0.03753825	0.31732544
Sucruse	-0.15453960	0.15047018	0.15068365
Cafeine	0.28462224	-0.10298584	-0.21498798
Trigoneline	-0.06606702	0.00458860	-0.14712096
Palmitic	0.12193723	-0.14327804	0.14178092
Linoleic	0.23457728	-0.12047570	-0.07409764
Oleic	-0.15392135	0.14851273	0.22680284
Estearic	-0.38350149	0.20583581	-0.05897217
Araquidic	0.03447093	-0.11816667	-0.36790320
prec_prom_anual	-0.12491539	0.19714710	-0.09370886
tmean_prom_anual	0.04589964	0.12094409	-0.06392605

Raw Canonical Coefficients			
Variable	**Can1**	**Can2**	**Can3**
SCORE	0.05969962	-0.05735001	-0.04135678
Altitude_m	0.36322020	0.06780333	0.08887882
P_Hum_Alm	-0.03268661	0.12772272	0.17327578
HULLING_LOSS	-0.05826903	-0.16373410	0.06944954
H_Beans	1.01002461	1.13864431	-0.25426783
Factor_Milling	0.72039710	0.04658610	0.11951833
AW_Alm	-0.03748930	0.14620132	-0.06397890
B_size_greater_16	-17.56577489	2.94540888	0.85963209
B_size_minus_16	-18.11979611	2.77350463	0.43886927
Lipids	0.07631875	-0.09633806	0.08183132
CQAT	-0.06220305	0.04071732	0.34419934
Sucruse	-0.16194640	0.15768194	0.15790564
Cafeine	0.33573737	-0.12148100	-0.25359754
Trigoneline	-0.06856783	0.00476230	-0.15268988
Palmitic	0.13566505	-0.15940843	0.15774276
Linoleic	0.29645393	-0.15225471	-0.09364306
Oleic	-0.17741971	0.17118539	0.26142764
Estearic	-0.50593884	0.27155132	-0.07779973
Araquidic	0.03878604	-0.13295889	-0.41395769
prec_prom_anual	-0.13458846	0.21241357	-0.10096539
tmean_prom_anual	0.05153264	0.13578690	-0.07177134

Class Means on Canonical Variables			
CLUSTER	**Can1**	**Can2**	**Can3**
1	-1.242645626	-1.920260492	0.478493812
2	-2.205018092	0.683950373	-1.359096988
3	1.723762218	-0.338368128	-0.530604015
4	-0.066863874	0.849244818	0.663724961



With this visual aid and the values of the variables highlighted on the canonical axes, the characteristic of the four clusters was presented.