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Interrelationships of Traits Measured on Fine-wool Rams During a Central Performance Test

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Summary

A pooled correlation analysis was conducted to estimate the relationships between all traits measured on fine-wool rams (n = 505) during three central performance tests (2000 - 2002). Introduction of minimum initial weight levels (for certification) was expected to have an effect on previously reported significant correlations. In addition to the reported traits, several other traits (measures of variability in fiber diameter, average fiber curvature and variability, for example) that have not previously been reported were included in the analysis. The correlation coefficients calculated are expected to assist breeders to better understand the consequences of their actions when selecting for individual traits. Observed differences between core and side sample average fiber diameters were not highly correlated with any other traits currently measured on the test. Average fiber curvature was not highly correlated with any measure of average fiber diameter but was negatively correlated with several important production traits which may have serious negative consequences for breeders who are selecting for or trying to maintain small crimp. Finally, older rams were shown to be at a disadvantage in the test because age is antagonistically correlated with most of the traits used to evaluate the rams.

Key words: traits, rams, central performance test

Introduction

Since 1948, the Texas Agricultural Experiment Station (TAES) has hosted a central performance test for yearling (9 to 16 mo old at end of test) rams to assist breeders in identifying their most productive young males. Innovations have been incorporated into the test procedure as new improvements in technology became available. One example is the measurement of average fiber diameter (AFD) and its variability (coefficient of variation, CV). Until a few years ago and because of the limitations of the projection microscope method, it was necessary to remove wool samples from the rams $2^1/_2$ mo before the reporting deadline (field day and sale) in order to have adequate time to measure the samples. Rather than shear the whole fleece at this early stage of the test, side samples were shorn and measured as indicators of the AFD of the whole fleece. A britch sample was also measured to indicate the AFD of a coarser portion of the fleece. Some years ago, TAES' acquisition of the Optical Fibre Diameter Analyser 100 (OFDA 100; Baxter et al., 1992) made it possible to subsample and measure the whole fleece shorn at the end of the growing period, just one month before the field day. After careful consideration, the side AFD and britch AFD were replaced by core sample AFD and CV for calculation of the index because the core sample values provide better estimates of the overall fleece AFD and variability. Nevertheless, because the breeders wanted the data, we continue to measure and report side and britch AFD's. We have calculated and reported the average difference between side and core AFD (about 0.7 µm) for the past five years. However, after noting the wide range in differences among individual rams, we have attempted to explain this variability in terms of all the other traits measured during the test procedure. We have also taken this opportunity to identify significant correlations between all the traits measured on these test animals in an attempt to identify any changes that have occurred since the last time these relationships were reported.

In addition to AFD and CV, the OFDA instrument is capable of concurrent measurement of average snippet (2 mm length of fiber) curvature (AFC) and CV. The AFC of snippets has been shown to provide a reasonable indication of fiber crimp propensity (Pfeiffer et al., 2001). Because of the general interest among breeders (and buyers and processors) in the appearance of wool and because of the technical textile implications of crimp, we have measured (but not reported) this trait on rams participating in the past three TAES performance tests. Our investigation of this trait and implications for breeders selecting for particular types of crimp are also reported here.

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Materials and Methods

Records collected on 505 rams completing the last three TAES Central Ram Performance Tests (Waldron and Lupton, 2000, 2001, and 2002) were used to conduct pooled correlation analysis (PCORR procedure of SAS [SAS Inst. Inc., Cary, NC]) between all traits measured and calculated for the test including several (e.g., AFC, and its variability) that were not previously reported. Multiple stepwise linear regression analysis (REG procedure of SAS) was used to identify those traits that best explained the side/core AFD differences (SAFD - CAFD) among rams.

Birthdate or birth month were reported for all the registered rams and most of the non-registered sheep during these three performance tests (total of 466 out of 505). For those with known birth months, ages at the end of the test were calculated and correlations were calculated between age and all the other reported traits.

Results and Discussion

Table 1 shows the mean, standard deviation, minimum, and maximum values for all the traits measured for the three ram tests being considered. The phenotypic relationships among many of these traits have been calculated and discussed previously (Shelton and Lewis, 1986; Lupton et al., 1997). The present discussion will consider the previously compared traits, but the main emphasis will be on traits that were not considered previously. One difference between the tests conducted between 1982 and 1986 and the present time is the current restriction (for certification purposes) on incoming or initial body weights. Minimum initial weights were introduced some years ago in an attempt to reduce the variability in this trait so that the comparisons among rams would be more meaningful. A more homogeneous (in terms of BW) initial population would be expected to affect some of the previously reported relationships. Pooled within-year correlation coefficients between traits measured and calculated on the 2000 - 2002 ram tests are summarized in Table 2.

Initial weight

The significant correlations with final weight (FW, +), grease fleece weight (GFW, +), folds score (FS, -), and scrotal circumference (SC, +) have been noted previously (Shelton and Lewis, 1986). However, previously reported significant correlations between IW and average daily gain (ADG), clean fleece weight (CFW), and average fiber diameter (AFD) are absent in this data set, possibly in part due to the current restriction on IW for certifiable animals. Significant negative correlations are present between IW and clean yield (CY, -), staple length (SL, -), and some of the measures of variability of side and britch fiber diameter. Generally, as IW increases, variability in side and britch fiber diameter tends to decrease. These correlations were not significant for the core measurements. The only high correlation was between IW and FW (0.76) which was very similar in magnitude to that reported by Shelton and Lewis in 1986 (0.77).

Final weight

The significant correlations with ADG (+), fleece weights (+), and SC (+) are again present. Completely absent are any significant correlations between FW and any of the four measures of AFD. Shelton and Lewis (1986) had reported small but significant correlations with side average fiber diameter (SAFD, 0.19) and britch average fiber diameter (BAFD, 0.16). In the populations of rams tested over the past three years, AFD appears to be independent of FW. As with IW, FW is significantly and negatively correlated with the side and britch measures of variability (SD and CV) of AFD. The fact that larger animals tend to be more uniform in fiber diameter is interpreted to reflect that less change in fiber diameter occurs in these animals during their time on test. There is a small but significant correlation between FW and average fiber curvature (AFC, -) indicating heavier rams tend to produce wool having bolder crimp. The FW is also significantly correlated with belly wool score (BWS, +) and FS (-), as was IW.

Average daily gain

The significant correlations with FW (+), GFW (+), CFW (+), and SC (+) are present, as previously reported (Shelton and Lewis, 1986). In addition, ADG is significantly correlated with SL (+), and negatively correlated with most of the measures of AFD variability and AFC. Higher gaining rams are positively associated with higher FS. With the fleece weight excluded from calculation of ADG, ADGB is obtained. As expected, these two measures of ADG are very highly correlated (r = 0.99). Correlations of ADGB with the other traits follow the same trend as ADG.

Grease fleece weight

As expected and previously reported, GFW is highly and positively correlated with CFW and SL. Smaller but significant correlations are present with IW, FW, ADG, SAFD, and core sample AFD (CAFD), indicating that larger fleeces tend to be coarser. The GFW is highly and negatively correlated with AFC (heavier fleeces tend to have bolder crimp), negatively correlated with BWS and positively correlated with FS and SC.

Clean yield

Clean yield is positively correlated with CFW (but not GFW) and SL and negatively and consistently correlated with the SD and CV of fiber diameter measurements (higher yielding fleeces tend to be less variable in terms of fiber diameter). The CY is negatively correlated with AFC and SDFC (higher yielding fleeces tend to have bolder crimp), (SAFD-CAFD), and BWS. Small positive correlations are present with FCS and FS.

Clean fleece weight

Clean fleece weight is positively correlated with FW, ADG, GFW, CY, SL, CAFD (but negatively with variability), PF, FCS, FS and SC. It is negatively correlated with (BAFD - SAFD) and (SAFD - CAFD), AFC and SDFC, and BWS. The potentially antagonistic correlations are with AFD, PF, FCS and FS. The significant correlation with IW as reported by Shelton and Lewis (1986) is no longer present, perhaps due in part to the relatively new restriction on starting weight.

Staple length

Staple length (SL) is positively and significantly correlated with ADG, GFW, CY, and CFW. In contrast, negative correlations are present with IW, all measures of AFD and their SD's and CV's, PF, AFC, SDFC and BWS. Longer staples are associated with finer, less variable fibers having bolder crimp. None of the significant correlations with SL are considered antagonistic. These correlations are similar in direc-

tion and magnitude with those reported by Shelton and Lewis (1986). However, the previously reported significant negative correlations with FCS and FS are absent from the current analysis.

Average fiber diameter

All measures of AFD are negatively correlated with SL and positively correlated to each other, their measures of variability (SD and CV), PF, and FS. The correlations with BWS are negative. Core AFD is positively correlated with GFW and CFW. Noteworthy are the absences of significant correlations with IW, FW, and AFC. Average fiber diameters in these three sets of animals appear to be independent of initial and final bodyweights and fiber curvature. This is quite different from the situation in 1982-1986 (Shelton and Lewis, 1986) when bigger rams tended to produce coarser wool and vice versa.

For the purpose of evaluating rams, there seems to be no advantage in using multiple AFD measurements made on samples removed from different locations (side, britch) versus a representative sample of the whole fleece (core). This is the basic conclusion of a previous study (Lupton et al., 1997).

Measures of variability in fiber diameter

Because CCVFD is used in the index we calculate for evaluating rams, this will be the focus of discussion. The CCVFD is negatively correlated with GFW, CY, CFW, SL, and SC, none of which are considered antagonistic. It is positively correlated with SSDFD, SCVFD, BAFD, BSDFD, BCVFD, CSDFD, PF, (BAFD - SAFD), AFC, SDFC, and BWS. Except for the significant correlation with BAFD, correlations with other measures of AFD are not significant.

Prickle factor

By definition, PF is the percentage of fibers greater than 30 m, so it is no surprise that PF is positively correlated with all measures of AFD and all measures of variability in fiber diameter. The PF is also positively associated with the fleece weights and FS but negatively correlated with SL and BWS.

(Britch average fiber diameter - Side average fiber diameter)

This trait was used by breeders for many years as an indicator of variability of fiber diameter in the fleece as a whole. It is significantly correlated with CCVFD (the best estimate of variability of fiber diameter in the fleece) but at a relatively low level, r = 0.15. Re-stated, the variability in (BAFD - SAFD) accounts for only 2% of the observed variability in CCVFD. This is why these measures were replaced by CAFD and CCVFD in the index. The magnitude of this relationship is quite similar to that reported previously for rams participating in the 1994 - 1996 tests (Lupton et al., 1997).

(Side sample - core sample average fiber diameter differences)

We rationalize that CAFD is generally less than SAFD because measurement of the latter does not include the relatively fine staple tip (Lupton and Shelton, 1986). Small but significant negative correlations are present between this calculated variable and GFW, CY, CFW, and SL. As these traits increase, there is a tendency for (SAFD - CAFD) to decrease. A relatively high (r = 0.45) correlation exists with SAFD but not CAFD (r = -0.08). A highly significant correlation (r = -0.33) is present between (BAFD - SAFD) and (SAFD - CAFD).

Stepwise multiple regression analysis was used to establish a relationship between (SAFD - CAFD) and all variables measured and calculated in the three ram tests being considered. When measures of AFD remained in the model, SAFD and CAFD enter the equation first and second (respectively) to produce an $r^2 = 1$. When all measures of AFD, SD, CV, and PF are omitted from the model, the only variable to enter the model for $P < 0.05$ is SDFC ($r^2 = 0.04$). No other variable meets the 0.05 significance level for entry into the model. When the three measures of AFD (only) are removed from the model, the variables entering the model to produce an $r^2 = 0.93$ were measures of variability of fiber diameter which themselves are significantly correlated with the mean values. The actual regression equation is:

(SAFD-CAFD) = 0.77 + 5.55 * SDFD – 1.25 * SCVFD – 4.40 * CSDFD + 0.96 * CCVFD

No other variables met the 0.05 significance level for entry into the equation. (SAFD - CAFD) is positively correlated with AFC and SDFC. In other words, this variable tends to increase as the AFC (and its variability) increases, i.e. as the staple crimp becomes smaller. In summary, these analyses do not shed much light on why (SAFD - CAFD) is so variable among rams. In the absence of a better explanation, we conclude the observed variability is likely due to differences in genetics, pre-test conditioning, and/or other things that we do not measure or calculate during the test (e.g., weight per day of age). Suffice it to say, the differences exist and they are real.

Average fiber curvature and variability

These traits have been measured concurrently with CAFD for the past three years. Negative correlations exist with ADG, GFW, CY, CFW, SL, and CVFC. Thus, selecting for increases in any of these traits will result in wool having bolder crimp. Positive correlations exist with SSDFD, SCVFD, CSDFD, CCVFD, (SAFD - CAFD) , and SDFC. In other words, selection for smaller crimp (higher AFC) will tend to increase variability in fiber diameter. Obviously, these results provide a serious warning to any breeder who is trying to produce wool having a small crimp while selecting for increases in wool production or rate of gain.

No significant correlations exist between AFC and any of the measures of AFD. In these populations of fine-wool rams, fiber crimp (measured as AFC) is obviously not a good indicator of AFD.

Face cover score

Face cover score is only significantly correlated with three traits, GFW (+), CY (+), and CFW (+). Intuitively, the relationships with fleece weights seems reasonable. We have no rationale for the other relationship. These relationships were not observed by Shelton and Lewis (1986). Conversely, we did not observe the significant negative correlation between FCS and SL reported earlier.

Belly wool score

Belly wool score is positively correlated with body weights and CCVFD and negatively correlated with fleece weights, CY,

SL, average fiber diameter and some measures of variability, PF, and FS. Thus, selecting for lower BWS will tend to result in heavier fleeces containing longer, cleaner and coarser wool produced by sheep having lower body weights and more folds.

Folds score

Folds score is positively correlated with ADG, GFW, CY, CFW, SAFD, CAFD, and PF and negatively correlated with IW, FW, BSDFD, and BWS.

Folds were bred off the Rambouillets during an era when a small cut inflicted during shearing would often result in death due to screw worm invasion. Screw worms no longer are present in Texas. More productive sheep have folds which appear to be quite acceptable in other countries. However, in Texas the demand has evolved for smooth-bodied rams. To change this perception of a "desirable ram" would be difficult. Most domestic shearers learned to shear on smooth sheep and appear to have great difficulty when asked to shear the occasional ewe having excessive folds or wrinkles.

Scrotal circumference

Scrotal circumference is positively correlated with body weights, ADG, fleece weights, CAFD, and PF. A significant, negative correlation exists with one of the measures of variability of fiber diameter (CCVFD).

Age

Age at the end of the performance test (11.7 ± 1.0 mo) is positively and significantly correlated with initial (highly, r = 0.64) and final body weights, all three measures of fiber diameter, PF, AFC, and SC. Age is negatively correlated with ADG, CY, CFW, SL, CVFC, FCS, and FS.

Age has an antagonistic correlation with all but one (CCVFD) of the traits used in the Index to evaluate animals, i.e. ADG, SL, CFW, and CAFD. Recognizing the disadvantage for older animals, fall-born rams (birth date before January 1) have traditionally been ranked separately from the spring-born animals. This is only an arbitrary cut-off and is not entirely satisfactory.

Implications

Numerous breeders use the TAES performance test to evaluate their rams. Many commercial sheep producers purchase performance-tested rams, their offspring and/or related sheep from the breeders. Often individuals are attempting to improve one or a few individual traits in their flock while maintaining or improving other traits. This report will assist them in understanding the likely consequences of selecting for a single trait.

Literature Cited

Baxter, B.P., M.A. Brims, and T.B. Taylor. 1992. Description and performance of the Optical Fibre Diameter Analyser (OFDA). J. Text. Inst. 83, 4: 507-526.

Lupton, C.J. and M. Shelton. 1986. Variation in wool fiber diameter from tip to base among Rambouillet rams on performance test. Texas Agric. Exp. Sta. Prog. Rep. 4401.

Lupton, C.J., D.F. Waldron, and F.A. Pfeiffer. 1997. Fiber diameter measurements of fine-wool rams on performance test. Sheep & Goat Res. J. 13, 2: 82-86.

Pfeiffer, F.A., C.J. Lupton, and B.A. Kuykendall. 2001. Predicting resistance to compression of wool fibers. J. Anim. Sci. 79, Suppl. 1: 276.

Shelton, M. and R. Lewis. 1986. Ram performance testing (in Texas) - a review and evaluation. Texas Agric. Exp. Sta. Res. Cen. Tech. Rep. 86-3.

Waldron, D.F. and C.J. Lupton. 2000, 2001, and 2002. Improvement of sheep through selection of performance-tested and progeny-tested breeding animals. Texas Agric. Exp. Sta. Res. Cen. Tech. Rep. 2000-1.

Table 1. Across year means and variability of ram traits measured and calculated for three central performance tests (2000 to 2002)

Trait	Mean	SD	Min	Max
Initial weight, lb	126.09	20.8	66	213
Final weight, lb	250.1	25.8	184	334
Average daily gain, lb/d	0.89	0.12	0.47	1.22
Average daily gain (body), lb/d	0.82	0.12	0.41	1.15
Grease fleece weight, lb	25.2	4.4	11.0	39.5
Clean yield, %	45.6	5.1	29.7	59.4
Clean fleece weight, lb	11.5	2.3	3.9	18.3
Staple length, in	5.4	0.6	3.5	7.0
Side sample, AFD, microns	22.6	1.4	18.6	27.2
SD, microns	3.7	0.5	2.6	7.1
CV, %	16.5	1.8	12.6	29.9
Britch sample, AFD, microns	25.0	1.9	19.3	32.4
SD, microns	4.4	0.8	2.7	8.7
CV, %	17.4	2.4	12.6	32.7
Core sample, AFD, microns	21.9	1.3	18.1	25.8
SD, microns	4.5	0.6	3.2	6.7
CV, %	20.5	2.5	15.6	29.7
Prickle factor, % fibers > 30 microns	3.9	3.0	0.2	21.4
(Britch AFD-Side AFD), microns	2.4	1.1	-1.9	9.6
(Side AFD-Core AFD), microns	0.7	0.8	-3.6	4.3
Average fiber curvature, deg/mm	91.1	10.4	63.5	124.0
SD, deg/mm	58.5	5.8	43.0	76.0
CV, %	64.3	3.1	56.4	73.8
Face cover score, 0-4	1.1	0.5	0.3	3.8
Belly wool score, 1-4	1.5	0.6	0.9	4.0
Folds score, 1-4	1.6	0.6	0.9	4.0
Scrotal circumference, cm	34.9	2.5	27.0	42.0
Age, mo	11.7	1.0	9	16

Glossary of Terms

IW:	Initial weight
FW:	Final weight
ADG:	Overall average daily gain
ADGB:	Average daily gain of body (grease wool not included)
GFW:	Grease fleece weight
CY:	Clean yield
CFW:	Clean fleece weight
SL:	Staple length
SAFD:	Average fiber diameter of side sample
SSDFD:	Standard deviation of fiber diameter of side sample
SCVFD:	Coefficient of variation of fiber diameter of side sample
BAFD:	Average fiber diameter of britch sample
BSDFD:	Standard deviation of fiber diameter of britch sample
BCVFD:	Coefficient of variation of fiber diameter of britch sample
CAFD:	Average fiber diameter of core sample from whole fleece
CSDFD:	Standard deviation of fiber diameter of core sample from whole fleece
CCVFD:	Coefficient of variation of fiber diameter of core sample from whole fleece
PF:	Prickle factor
(BAFD - SAFD):	Average fiber diameter of britch sample - average fiber diameter of side sample
(SAFD - CAFD):	Average fiber diameter of side sample - average fiber diameter of core sample
AFC:	Average fiber curvature
SDFC:	Standard deviation of fiber curvature
CVFC:	Coefficient of variation of fiber curvature
FCS:	Face cover score
BWS:	Belly wool score
FS:	Folds score
SC:	Scrotal circumference
AGE:	Age in months at end of performance test

Table 2. Pooled within-year correlation coefficients for traits measured and calculated on ram central performance tests

	FW	ADG	ADGB	GFW	CY	CFW	SL	SAFD	SSDFD	SCVFD	BAFD	BSDFD	BCVFD	CAFD
IW	**0.76****	-0.07	-0.09*	**0.20****	**-0.16****	0.08	-0.09*	0.05	-0.06	-0.10*	0.02	-0.08*	-0.11*	0.05
FW		**0.59****	**0.57****	**0.45****	**-0.12****	**0.31****	0.08	-0.01	**-0.19****	**-0.22****	-0.02	**-0.12****	**-0.15****	-0.01
ADG			**0.99****	**0.44****	0.00	**0.37****	**0.25****	-0.07	**-0.22****	**-0.21****	-0.06	-0.10*	-0.10*	-0.08
ADGB				**0.36****	-0.00	**0.30****	**0.21****	-0.09	**-0.23****	**-0.22****	-0.06	-0.11*	**-0.12****	-0.10*
GFW					0.05	**0.87****	**0.48****	0.11*	0.03	-0.03	0.03	**0.12****	**0.13****	**0.20****
CY						**0.53****	**0.45****	-0.03	-0.11*	-0.11*	-0.07	-0.02	-0.02	0.05
CFW							**0.63****	0.08	-0.02	-0.07	-0.01	0.10*	**0.12****	**0.19****
SL								**-0.16****	**-0.21****	**-0.15****	**-0.16****	-0.10*	-0.04	-0.10*
SAFD									**0.52****	0.00	**0.80****	**0.51****	**0.20****	**0.86****
SSDFD										**0.85****	**0.38****	**0.60****	**0.56****	**0.41****
SCVFD											-0.04	**0.40****	**0.54****	-0.04
BAFD												**0.64****	**0.26****	**0.81****
BSDFD													**0.90****	**0.58****
BCVFD														**0.28****

* $P < 0.05$, significant; ** $P < 0.01$, highly significant.

Table 2. Pooled within-year correlation coefficients for traits measured and calculated on ram central performance tests (continued)

	CSDFD	CCVFD	PF	(BAFD-SAFD)	(SAFD-CAFD)	AFC	SDFC	CVFC	FCS	BWS	FS	SC	AGE
IW	-0.03	-0.07	0.05	-0.03	0.01	0.07	0.03	-0.11*	-0.04	**0.13****	**-0.30****	**0.32****	**0.64****
FW	-0.06	-0.07	-0.01	-0.02	0.01	-0.11*	**-0.12****	0.03	0.02	**0.13****	**-0.16****	**0.39****	**0.38****
ADG	-0.06	-0.02	-0.08	-0.00	0.01	**-0.26****	**-0.21****	**0.19****	0.07	0.03	**0.12****	**0.20****	**-0.22****
ADGB	-0.06	-0.01	0.10*	-0.01	0.02	**-0.22****	**-0.17****	**0.17****	0.07	0.06	0.08*	**0.19****	**-0.22****
GFW	0.01	**-0.12****	**0.17****	-0.09*	**-0.12****	**-0.52****	**-0.49****	**0.25****	0.09*	**-0.27****	**0.39****	**0.22****	-0.04
CY	**-0.19****	**-0.24****	-0.03	-0.08	**-0.14****	**-0.48****	**-0.48****	**0.15****	0.09*	-0.10*	**0.13****	0.05	-0.11*
CFW	-0.09*	**-0.21****	**0.14****	**-0.12****	**-0.16****	**-0.67****	**-0.64****	**0.28****	**0.12****	**-0.28****	**0.40****	**0.16****	-0.09*
SL	**-0.24****	**-0.22****	**-0.14****	-0.06	**-0.13****	**-0.72****	**-0.66****	**0.38****	-0.02	**-0.12****	0.06	0.01	**-0.14****
SAFD	**0.43****	0.05	**0.74****	0.05	**0.45****	0.04	-0.00	**-0.13****	0.07	**-0.27****	**0.16****	0.07	**0.15****
SSDFD	**0.37****	**0.21****	**0.51****	-0.03	**0.28****	**0.12****	**0.13****	0.03	0.01	**-0.13****	**0.20****	-0.02	0.03
SCVFD	**0.17****	**0.22****	**0.14****	-0.06	0.06	0.11*	**0.15****	0.05	-0.02	0.01	**0.13****	-0.07	-0.06
BAFD	**0.47****	**0.12****	**0.74****	**0.64****	**0.15****	0.04	-0.00	**-0.13****	0.05	**-0.20****	0.08	0.09	**0.18****
BSDFD	**0.48****	**0.25****	**0.67****	**0.42****	-0.02	0.01	-0.00	-0.03	-0.03	**-0.19****	**-0.23****	0.08	0.07
BCVFD	**0.35****	**0.25****	**0.41****	**0.18****	-0.11*	-0.01	-0.01	0.03	-0.06	**-0.14****	**0.23****	0.05	-0.01
CAFD	**0.48****	0.05	**0.84****	**0.25****	-0.08	-0.04	-0.11*	**-0.16****	0.08	**-0.30****	**0.20****	0.10*	**0.15****
CSDFD		**0.90****	**0.59****	**0.24****	-0.02	**0.13****	**0.15****	0.00	0.06	-0.02	0.07	-0.08	0.06
CCVFD			**0.25****	**0.15****	0.02	**0.17****	**0.23****	0.08	0.03	**0.13****	-0.02	**-0.15****	-0.00
PF				**0.28****	-0.06	-0.00	-0.04	-0.11*	0.08	**-0.25****	**0.23****	0.10*	**0.16****
(BAFD-SAFD)					**-0.33****	0.02	0.00	-0.06	-0.01	0.02	-0.07	0.06	0.10*
(SAFD-CAFD)						**0.16****	**0.18****	0.01	0.02	0.02	-0.04	-0.07	0.04
AFC							**0.93****	**-0.51****	-0.06	0.06	-0.05	-0.05	**0.13****
SDFC								**-0.14****	-0.05	0.01	-0.04	-0.09	0.06
CVFC									0.06	**-0.12****	0.05	-0.06	**-0.20****
FCS										0.11*	0.04	-0.09	**-0.13****
BWS											**-0.36****	-0.01	0.07
FS												-0.02	**-0.24****
SC													**0.36****

* P < 0.05, significant; ** P < 0.01, highly significant.