

The `ammistability` Package: A Brief Introduction

Ajay, B. C.¹, Aravind, J.², and Abdul Fiyaz, R.³

2023-05-23

1. RRS, ICAR-Directorate of Groundnut Research, Anantapur.
2. ICAR-National Bureau of Plant Genetic Resources, New Delhi.
3. ICAR-Indian Institute of Rice Research, Hyderabad.

Contents

Overview	1
Installation	2
Version History	2
AMMI model	2
AMMI stability parameters	3
Simultaneous selection indices for yield and stability	36
Wrapper function	39
Citing <code>ammistability</code>	48
Session Info	49
References	49

Overview

The package `ammistability` (Ajay et al., 2019a) is a collection of functions for the computation of various stability parameters from the results of Additive Main Effects and Multiplicative Interaction (AMMI) analysis computed by the `AMMI` function of `agricolae` package.

The goal of this vignette is to introduce the users to these functions and give a primer in computation of various stability parameters/indices from a fitted AMMI model. This document assumes a basic knowledge of R programming language.



Installation

The package can be installed from CRAN as follows:

```
# Install from CRAN
install.packages('ammistability', dependencies=TRUE)
```

The development version can be installed from github as follows:

```
# Install development version from Github
devtools::install_github("ajaygp/ammistability")
```

Then the package can be loaded using the function

```
library(ammistability)
```

Welcome to ammistability version 0.1.4

```
# To know how to use this package type:
browseVignettes(package = 'ammistability')
for the package vignette.
```

```
# To know whats new in this version type:
news(package='ammistability')
for the NEWS file.
```

```
# To cite the methods in the package type:
citation(package='ammistability')
```

```
# To suppress this message use:
suppressPackageStartupMessages(library(ammistability))
```

Version History

The current version of the package is 0.1.4. The previous versions are as follows.

Table 1. Version history of ammistability R package.

Version	Date
0.1.0	2018-08-13
0.1.1	2018-12-07
0.1.2	2021-02-23
0.1.3	2022-07-18

To know detailed history of changes use `news(package='ammistability')`.

AMMI model

The difference in response of genotypes to different environmental conditions is known as Genotype-Environment Interaction (GEI). Understanding the nature and structure of this interaction is critical for plant breeders to select for genotypes with wide or specific adaptability. One of the most popular

techniques to achieve this is by fitting the Additive Main Effects and Multiplicative Interaction (AMMI) model to the results of multi environment trials (Gauch, 1988, 1992).

The AMMI equation is described as follows.

$$Y_{ij} = \mu + \alpha_i + \beta_j + \sum_{n=1}^N \lambda_n \gamma_{in} \delta_{jn} + \rho_{ij}$$

Where, Y_{ij} is the yield of the i th genotype in the j th environment, μ is the grand mean, α_i is the genotype deviation from the grand mean, β_j is the environment deviation, N is the total number of interaction principal components (IPCs), λ_n is the singular value for n th IPC and correspondingly λ_n^2 is its eigen value, γ_{in} is the eigenvector value for i th genotype, δ_{jn} is the eigenvector value for the j th environment and ρ_{ij} is the residual.

AMMI stability parameters

Although the AMMI model can aid in determining genotypes with wide or specific adaptability, it fails to rank genotypes according to their stability. Several measures have been developed over the years to indicate the stability of genotypes from the results of AMMI analysis (Table 1.).

The details about AMMI stability parameters/indices implemented in `ammistability` are described in Table 1.

Table 1 : AMMI stability parameters/indices implemented in `ammistability`.

AMMI stability parameter	function	Details	Reference
Sum across environments of GEI modelled by AMMI (<i>AMGE</i>)	<code>AMGE.AMMI</code>	$AMGE = \sum_{j=1}^E \sum_{n=1}^{N'} \lambda_n \gamma_{in} \delta_{jn}$	Sneller et al. (1997)
AMMI Stability Index (<i>ASI</i>)	<code>ASI.AMMI</code> and <code>MASI.AMMI</code>	$ASI = \sqrt{[PC_1^2 \times \theta_1^2] + [PC_2^2 \times \theta_2^2]}$	Jambhulkar et al. (2014); Jambhulkar et al. (2015); Jambhulkar et al. (2017)
AMMI Based Stability Parameter (<i>ASTAB</i>)	<code>ASTAB.AMMI</code>	$ASTAB = \sum_{n=1}^{N'} \lambda_n \gamma_{in}^2$	Rao and Prabhakaran (2005)
AMMI stability value (<i>ASV</i>) *	<code>agricolae::index.AMMI</code> and <code>MASV.AMMI</code>	Distance from the coordinate point to the origin in a two dimensional scattergram generated by plotting of IPC1 score against IPC2 score.	Purchase (1997); Purchase et al. (1999); Purchase et al. (2000)
		$ASV = \sqrt{\left(\frac{SSIPC_1}{SSIPC_2} \times PC_1\right)^2 + (PC_2)^2}$	
$AV_{(AMGE)}$	<code>AVAMGE.AMMI</code>	$AV_{(AMGE)} = \sum_{j=1}^E \sum_{n=1}^{N'} \lambda_n \gamma_{in} \delta_{jn} $	Zali et al. (2012)
Annicchiarico's D parameter (<i>D_a</i>)	<code>DA.AMMI</code>	The unsquared Euclidean distance from the origin of significant IPC axes in the AMMI model.	Annicchiarico (1997)
		$D_a = \sqrt{\sum_{n=1}^{N'} (\lambda_n \gamma_{in})^2}$	
Zhang's D parameter or AMMI statistic coefficient or AMMI distance or AMMI stability index (<i>D_z</i>)	<code>DZ.AMMI</code>	The distance of IPC point from origin in space.	Zhang et al. (1998)
		$D_z = \sqrt{\sum_{n=1}^{N'} \gamma_{in}^2}$	
Averages of the squared eigenvector values <i>EV</i>	<code>EV.AMMI</code>	$EV = \sum_{n=1}^{N'} \frac{\gamma_{in}^2}{N'}$	Zobel (1994)
Stability measure based on fitted AMMI model <i>FA</i>	<code>FA.AMMI</code>	$FA = \sum_{n=1}^{N'} \lambda_n^2 \gamma_{in}^2$	Raju (2002); Zali et al. (2012)

AMMI stability parameter	function	Details	Reference
FP	FA.AMMI	Equivalent to FA , when only the first IPC axis is considered for computation. $FP = \lambda_1^2 \gamma_{i1}^2$ As λ_1^2 will be same for all the genotypes, the absolute value of γ_{i1} alone is sufficient for comparison. So this is also equivalent to the comparison based on biplot with first IPC axis.	Raju (2002); Zali et al. (2012)
B	FA.AMMI	Equivalent to FA , when only the first two IPC axes are considered for computation. $B = \sum_{n=1}^2 \lambda_n^2 \gamma_{in}^2$ Stability comparisons based on this measure will be equivalent to the comparisons based on biplot with first two IPC axes.	Raju (2002); Zali et al. (2012)
$W_{(AMMI)}$	FA.AMMI	Equivalent to FA , when all the IPC axes in the AMMI model are considered for computation. $W_{(AMMI)} = \sum_{n=1}^N \lambda_n^2 \gamma_{in}^2$ Equivalent to Wricke's ecovalence.	Wricke (1962); Raju (2002); Zali et al. (2012)
Modified AMMI Stability Index ($MASI$)	MASI.AMMI	$MASI = \sqrt{\sum_{n=1}^{N'} PC_n^2 \times \theta_n^2}$	Ajay et al. (2018)
Modified AMMI stability value ($MASV$)	MASV.AMMI	$MASV = \sqrt{\sum_{n=1}^{N'-1} \left(\frac{SSIPC_n}{SSIPC_{n+1}} \times PC_n \right)^2 + (PC_{N'})^2}$	Ajay et al. (2019b); Zali et al. (2012)

AMMI stability parameter	function	Details	Reference
Sums of the absolute value of the IPC scores (<i>SIPC</i>)	<code>SIPC.AMMI</code>	$SIPC = \sum_{n=1}^{N'} \lambda_n^{0.5} \gamma_{in} $ $SIPC = \sum_{n=1}^{N'} PC_n $	Sneller et al. (1997)
Absolute value of the relative contribution of IPCs to the interaction (<i>Za</i>)	<code>ZA.AMMI</code>	$Za = \sum_{i=1}^{N'} \theta_n \gamma_{in} $	Zali et al. (2012)

Where, N is the total number of interaction principal components (IPCs); N' is the number of significant IPCAs (number of IPC that were retained in the AMMI model via F tests); λ_n is the singular value for n th IPC and correspondingly λ_n^2 is its eigen value; γ_{in} is the eigenvector value for i th genotype; δ_{jn} is the eigenvector value for the j th environment; $SSIPC_1, SSIPC_2, \dots, SSIPC_n$ are the sum of squares of the 1st, 2th, \dots , and n th IPC; PC_1, PC_2, \dots, PC_n are the scores of 1st, 2th, \dots , and n th IPC; θ_n is the percentage sum of squares explained by n th principal component interaction effect; and E is the number of environments.

Examples

```
library(agricolae)
data(plrv)

# AMMI model
model <- with(plrv, AMMI(Locality, Genotype, Rep, Yield, console = FALSE))

# ANOVA
model$ANOVA
```

AMMI model from agricolae::AMMI

Analysis of Variance Table

Response: Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
ENV	5	122284	24456.9	257.0382	9.08e-12	***
REP(ENV)	12	1142	95.1	2.5694	0.002889	**
GEN	27	17533	649.4	17.5359	< 2.2e-16	***
ENV:GEN	135	23762	176.0	4.7531	< 2.2e-16	***
Residuals	324	11998	37.0			

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```
# IPC F test
model$analysis
```

	percent	acum	Df	Sum.Sq	Mean.Sq	F.value	Pr.F
PC1	56.3	56.3	31	13368.5954	431.24501	11.65	0.0000
PC2	27.1	83.3	29	6427.5799	221.64069	5.99	0.0000
PC3	9.4	92.7	27	2241.9398	83.03481	2.24	0.0005
PC4	4.3	97.1	25	1027.5785	41.10314	1.11	0.3286
PC5	2.9	100.0	23	696.1012	30.26527	0.82	0.7059

```
# Mean yield and IPC scores
model$bplot
```

	type	Yield	PC1	PC2	PC3	PC4
102.18	GEN	26.31947	-1.50828851	1.258765244	-0.19220309	0.48738861
104.22	GEN	31.28887	0.32517729	-1.297024517	-0.63695749	-0.44159957
121.31	GEN	30.10174	0.95604605	1.143461054	-1.28777348	2.22246913
141.28	GEN	39.75624	2.11153737	0.817810467	1.45527701	0.25257620
157.26	GEN	36.95181	1.05139017	2.461179974	-1.97208942	-1.96538800
163.9	GEN	21.41747	-2.12407441	-0.284381234	-0.21791137	-0.50743629
221.19	GEN	22.98480	-0.84981828	0.347983673	-0.82400783	-0.11451944
233.11	GEN	28.66655	0.07554203	-1.046497338	1.04040485	0.22868362
235.6	GEN	38.63477	1.20102029	-2.816581184	0.80975361	1.02013062
241.2	GEN	26.34039	-0.79948495	0.220768053	-0.98538801	0.30004421
255.7	GEN	30.58975	-1.49543817	-1.186549449	0.92552519	-0.32009239
314.12	GEN	28.17335	1.39335380	-0.332786322	-0.73226877	0.05987348
317.6	GEN	35.32583	1.05170769	0.002555823	-0.81561907	0.58180433
319.20	GEN	38.75767	3.08338144	1.995946966	0.87971668	-1.11908943
320.16	GEN	26.34808	-1.55737097	0.732314249	-0.41432567	1.32097009
342.15	GEN	26.01336	-1.35880873	-0.741980068	0.87480105	-1.12013125

346.2	GEN	23.84175	-2.48453928	-0.397045286	1.07091711	-0.90974484
351.26	GEN	36.11581	1.22670345	1.537183139	1.79835728	-0.03516368
364.21	GEN	34.05974	0.27328985	-0.447941156	0.03139543	0.77920500
402.7	GEN	27.47748	-0.12907269	-0.080086669	0.01934016	-0.36085862
405.2	GEN	28.98663	-1.90936369	0.309047963	0.57682642	0.51163370
406.12	GEN	32.68323	0.90781100	-1.733433781	-0.24223050	-0.38596144
427.7	GEN	36.19020	0.42791957	-0.723190970	-0.85381724	-0.53089914
450.3	GEN	36.19602	1.38026196	1.279525147	0.16025163	0.61270137
506.2	GEN	33.26623	-0.33054261	-0.302588536	-1.58471588	-0.04659416
Canchan	GEN	27.00126	1.47802905	0.380553178	1.67423900	0.07718375
Desiree	GEN	16.15569	-3.64968796	1.720025405	0.43761089	0.04648011
Unica	GEN	39.10400	1.25331924	-2.817033826	-0.99510845	-0.64366599
Ayac	ENV	23.70254	-2.29611851	0.966037760	1.95959116	2.75548057
Hyo-02	ENV	45.73082	3.85283195	-5.093371615	1.16967118	-0.08985538
LM-02	ENV	34.64462	-1.14575146	-0.881093222	-4.56547274	0.55159099
LM-03	ENV	53.83493	5.34625518	4.265275487	-0.14143931	-0.11714533
SR-02	ENV	14.95128	-2.58678337	0.660309540	0.89096920	-3.25055305
SR-03	ENV	11.15328	-3.17043379	0.082842050	0.68668051	0.15048221
	PC5					
102.18			-0.04364115			
104.22			0.95312506			
121.31			-1.30661916			
141.28			-0.25996142			
157.26			-0.59719268			
163.9			0.18563390			
221.19			-0.57504816			
233.11			0.65754266			
235.6			-0.40273415			
241.2			0.07555258			
255.7			-0.46344763			
314.12			0.54406154			
317.6			0.39627052			
319.20			0.29657050			
320.16			2.29506737			
342.15			-0.10776433			
346.2			-0.12738693			
351.26			0.30191335			
364.21			-0.95811256			
402.7			-0.28473777			
405.2			-0.34397623			
406.12			-0.49796296			
427.7			1.00677993			
450.3			-0.34325251			
506.2			0.87807441			
Canchan			0.49381313			
Desiree			-0.86767477			
Unica			-0.90489253			
Ayac			1.67177210			
Hyo-02			0.01540152			
LM-02			0.52350416			
LM-03			-0.40285728			
SR-02			1.37283488			
SR-03			-3.18065538			


```
# G*E matrix (deviations from mean)
array(model$genXenv, dim(model$genXenv), dimnames(model$genXenv))
```

GEN	ENV				
	Ayac	Hyo-02	LM-02	LM-03	SR-02
102.18	5.5726162	-12.4918224	1.7425251	-2.7070438	2.91734869
104.22	-2.8712076	7.1684102	3.9336218	-4.0358373	0.47881580
121.31	0.3255230	-3.8666836	4.3182811	10.4366135	-11.88343843
141.28	-0.9451837	5.6454825	-9.7806639	14.6463104	-4.80337115
157.26	-10.3149711	-10.6241677	4.2336365	16.8683612	2.71710210
163.9	3.0874931	-6.9416721	3.4963790	-12.5533271	7.01688164
221.19	-0.6041752	-6.0090018	4.0648518	-2.6974743	1.27671246
233.11	2.5837535	6.8277609	-3.4440645	-4.4985717	0.19989490
235.6	-1.7541523	19.8225025	-2.2394463	-5.6643239	-8.11400542
241.2	1.0710975	-5.3831118	5.4253097	-3.2588271	0.46433086
255.7	2.4443155	1.3860497	-1.8857757	-12.9626594	4.31373929
314.12	-3.8812099	6.2098482	2.3577759	5.9071782	-3.92419060
317.6	-1.7450319	3.0388540	3.0448064	5.5211634	-4.79271565
319.20	-6.0155949	2.8477540	-9.7697504	24.8850017	-1.82949467
320.16	10.9481796	-10.2982108	4.9608280	-6.2233088	2.99984918
342.15	0.8508002	-0.3338618	-2.4575390	-10.3783871	7.29753151
346.2	4.7000495	-6.2178087	-2.2612391	-14.9700672	9.90123888
351.26	2.6002030	-0.9918665	-10.8315931	12.7429121	-0.02713985
364.21	-0.4533734	3.2864208	-0.1335527	-0.1592533	-4.82292664
402.7	-1.2134573	-0.0387229	-0.2179557	-0.8774011	1.08032472
405.2	6.6477681	-8.3071271	-0.6159895	-8.8927189	3.52179705
406.12	-6.1296667	12.0703469	1.1195092	-2.2601009	-3.13776595
427.7	-3.1340922	4.3967072	4.2792028	-1.0194744	0.76266844
450.3	-0.5047010	-1.0720791	-3.2821761	12.8806007	-5.04562407
506.2	-1.2991912	-1.5682154	8.3142802	-3.1819279	0.60021498
Canchan	1.2929442	5.7152780	-9.3713622	9.0803035	-1.65332869
Desiree	9.5767845	-22.3280421	0.2396387	-11.8935722	9.62433886
Unica	-10.8355195	18.0569790	4.7604622	-4.7341684	-5.13878822

GEN	ENV
	SR-03
102.18	4.9663762
104.22	-4.6738028
121.31	0.6697043
141.28	-4.7625741
157.26	-2.8799609
163.9	5.8942454
221.19	3.9690870
233.11	-1.6687730
235.6	-2.0505746
241.2	1.6812008
255.7	6.7043306
314.12	-6.6694018
317.6	-5.0670763
319.20	-10.1179157
320.16	-2.3873373
342.15	5.0214562
346.2	8.8478267
351.26	-3.4925156
364.21	2.2826853

```

402.7    1.2672123
405.2    7.6462704
406.12   -1.6623226
427.7    -5.2850119
450.3    -2.9760204
506.2    -2.8651608
Canchan  -5.0638348
Desiree  14.7808522
Unica    -2.1089651

```

```

# With default n (N') and default ssi.method (farshadfar)
AMGE.AMMI(model)

```

```
AMGE.AMMI()
```

	AMGE	SSI	rAMGE	rY	means
102.18	1.598721e-14	48	25	23	26.31947
104.22	-8.881784e-15	20	7	13	31.28887
121.31	1.643130e-14	41	26	15	30.10174
141.28	-4.440892e-15	11	10	1	39.75624
157.26	3.241851e-14	33	28	5	36.95181
163.9	3.108624e-15	45	18	27	21.41747
221.19	8.881784e-15	48	22	26	22.98480
233.11	-1.476597e-14	22	5	17	28.66655
235.6	-2.975398e-14	5	1	4	38.63477
241.2	7.105427e-15	42	20	22	26.34039
255.7	-1.598721e-14	18	4	14	30.58975
314.12	-1.776357e-15	31	13	18	28.17335
317.6	1.776357e-15	26	17	9	35.32583
319.20	8.437695e-15	24	21	3	38.75767
320.16	1.154632e-14	45	24	21	26.34808
342.15	-9.325873e-15	30	6	24	26.01336
346.2	-3.552714e-15	36	11	25	23.84175
351.26	1.110223e-15	24	16	8	36.11581
364.21	-4.940492e-15	19	9	10	34.05974
402.7	-4.163336e-16	33	14	19	27.47748
405.2	8.881784e-16	31	15	16	28.98663
406.12	-1.731948e-14	15	3	12	32.68323
427.7	-2.553513e-15	19	12	7	36.19020
450.3	1.021405e-14	29	23	6	36.19602
506.2	6.439294e-15	30	19	11	33.26623
Canchan	-7.993606e-15	28	8	20	27.00126
Desiree	1.754152e-14	55	27	28	16.15569
Unica	-2.042810e-14	4	2	2	39.10400

```

# With n = 4 and default ssi.method (farshadfar)
AMGE.AMMI(model, n = 4)

```

	AMGE	SSI	rAMGE	rY	means
102.18	1.643130e-14	48.0	25.0	23	26.31947
104.22	-9.325873e-15	20.0	7.0	13	31.28887
121.31	1.731948e-14	41.0	26.0	15	30.10174
141.28	-4.218847e-15	11.5	10.5	1	39.75624
157.26	3.019807e-14	33.0	28.0	5	36.95181
163.9	2.664535e-15	45.0	18.0	27	21.41747

```

221.19  8.271162e-15 48.0  22.0 26 22.98480
233.11 -1.409983e-14 22.0   5.0 17 28.66655
235.6  -2.797762e-14  5.0   1.0  4 38.63477
241.2   6.883383e-15 42.0  20.0 22 26.34039
255.7  -1.709743e-14 18.0   4.0 14 30.58975
314.12 -2.664535e-15 31.0  13.0 18 28.17335
317.6   2.220446e-15 26.0  17.0  9 35.32583
319.20  7.549517e-15 24.0  21.0  3 38.75767
320.16  1.243450e-14 45.0  24.0 21 26.34808
342.15 -1.132427e-14 30.0   6.0 24 26.01336
346.2  -4.440892e-15 34.0   9.0 25 23.84175
351.26  1.110223e-15 23.0  15.0  8 36.11581
364.21 -3.774758e-15 22.0  12.0 10 34.05974
402.7  -9.159340e-16 33.0  14.0 19 27.47748
405.2   1.165734e-15 32.0  16.0 16 28.98663
406.12 -1.820766e-14 15.0   3.0 12 32.68323
427.7  -4.218847e-15 17.5  10.5  7 36.19020
450.3   9.992007e-15 29.0  23.0  6 36.19602
506.2   6.522560e-15 30.0  19.0 11 33.26623
Canchan -6.994405e-15 28.0   8.0 20 27.00126
Desiree 1.743050e-14 55.0  27.0 28 16.15569
Unica  -2.220446e-14  4.0   2.0  2 39.10400

```

```

# With default n (N') and ssi.method = "rao"
AMGE.AMMI(model, ssi.method = "rao")

```

	AMGE	SSI	rAMGE	rY	means
102.18	1.598721e-14	-1.209920	25	23	26.31947
104.22	-8.881784e-15	4.742740	7	13	31.28887
121.31	1.643130e-14	-1.030703	26	15	30.10174
141.28	-4.440892e-15	8.741371	10	1	39.75624
157.26	3.241851e-14	0.184960	28	5	36.95181
163.9	3.108624e-15	-9.937521	18	27	21.41747
221.19	8.881784e-15	-2.973115	22	26	22.98480
233.11	-1.476597e-14	3.173817	5	17	28.66655
235.6	-2.975398e-14	2.370918	1	4	38.63477
241.2	7.105427e-15	-3.794340	20	22	26.34039
255.7	-1.598721e-14	3.065479	4	14	30.58975
314.12	-1.776357e-15	19.531348	13	18	28.17335
317.6	1.776357e-15	-17.460918	17	9	35.32583
319.20	8.437695e-15	-2.654754	21	3	38.75767
320.16	1.154632e-14	-2.004403	24	21	26.34808
342.15	-9.325873e-15	4.393465	6	24	26.01336
346.2	-3.552714e-15	10.083744	11	25	23.84175
351.26	1.110223e-15	-28.602804	16	8	36.11581
364.21	-4.940492e-15	7.802759	9	10	34.05974
402.7	-4.163336e-16	80.310270	14	19	27.47748
405.2	8.881784e-16	-36.280350	15	16	28.98663
406.12	-1.731948e-14	2.974655	3	12	32.68323
427.7	-2.553513e-15	14.127995	12	7	36.19020
450.3	1.021405e-14	-2.056805	23	6	36.19602
506.2	6.439294e-15	-4.049883	19	11	33.26623
Canchan	-7.993606e-15	5.016556	8	20	27.00126
Desiree	1.754152e-14	-1.358068	27	28	16.15569
Unica	-2.042810e-14	2.893508	2	2	39.10400

```
# Changing the ratio of weights for Rao's SSI
AMGE.AMMI(model, ssi.method = "rao", a = 0.43)
```

	AMGE	SSI	rAMGE	rY	means
102.18	1.598721e-14	-0.03111319	25	23	26.31947
104.22	-8.881784e-15	2.62088777	7	13	31.28887
121.31	1.643130e-14	0.11624442	26	15	30.10174
141.28	-4.440892e-15	4.49766702	10	1	39.75624
157.26	3.241851e-14	0.76628938	28	5	36.95181
163.9	3.108624e-15	-3.87508635	18	27	21.41747
221.19	8.881784e-15	-0.85126241	22	26	22.98480
233.11	-1.476597e-14	1.89751451	5	17	28.66655
235.6	-2.975398e-14	1.73752955	1	4	38.63477
241.2	7.105427e-15	-1.14202521	20	22	26.34039
255.7	-1.598721e-14	1.88667228	4	14	30.58975
314.12	-1.776357e-15	8.92208663	13	18	28.17335
317.6	1.776357e-15	-6.85165762	17	9	35.32583
319.20	8.437695e-15	-0.42122552	21	3	38.75767
320.16	1.154632e-14	-0.37220928	24	21	26.34808
342.15	-9.325873e-15	2.37265314	6	24	26.01336
346.2	-3.552714e-15	4.77911338	11	25	23.84175
351.26	1.110223e-15	-11.62798636	16	8	36.11581
364.21	-4.940492e-15	3.98819325	9	10	34.05974
402.7	-4.163336e-16	35.04409044	14	19	27.47748
405.2	8.881784e-16	-15.06182868	15	16	28.98663
406.12	-1.731948e-14	1.88652568	3	12	32.68323
427.7	-2.553513e-15	6.74763968	12	7	36.19020
450.3	1.021405e-14	-0.21171610	23	6	36.19602
506.2	6.439294e-15	-1.12319038	19	11	33.26623
Canchan	-7.993606e-15	2.65894277	8	20	27.00126
Desiree	1.754152e-14	-0.28371280	27	28	16.15569
Unica	-2.042810e-14	1.97096400	2	2	39.10400

```
# With default ssi.method (farshadfar)
ASI.AMMI(model)
```

```
ASI.AMMI()
```

	ASI	SSI	rASI	rY	means
102.18	0.91512303	43	20	23	26.31947
104.22	0.39631322	19	6	13	31.28887
121.31	0.62108102	25	10	15	30.10174
141.28	1.20927797	26	25	1	39.75624
157.26	0.89176583	22	17	5	36.95181
163.9	1.19833464	51	24	27	21.41747
221.19	0.48765291	34	8	26	22.98480
233.11	0.28677206	21	4	17	28.66655
235.6	1.01971997	25	21	4	38.63477
241.2	0.45406877	29	7	22	26.34039
255.7	0.90124720	33	19	14	30.58975
314.12	0.78962523	30	12	18	28.17335
317.6	0.59211183	18	9	9	35.32583
319.20	1.81826161	30	27	3	38.75767
320.16	0.89897900	39	18	21	26.34808

```

342.15  0.79099371  37  13 24 26.01336
346.2   1.40292793  51  26 25 23.84175
351.26  0.80654291  22  14  8 36.11581
364.21  0.19598368  12   2 10 34.05974
402.7   0.07583976  20   1 19 27.47748
405.2   1.07822942  39  23 16 28.98663
406.12  0.69418710  23  11 12 32.68323
427.7   0.31056699  12   5  7 36.19020
450.3   0.85094150  22  16  6 36.19602
506.2   0.20336120  14   3 11 33.26623
Canchan 0.83849670  35  15 20 27.00126
Desiree 2.10698168  56  28 28 16.15569
Unica   1.03956820  24  22  2 39.10400

```

```

# With ssi.method = "rao"
ASI.AMMI(model, ssi.method = "rao")

```

	ASI	SSI	rASI	rY	means
102.18	0.91512303	1.3832387	20	23	26.31947
104.22	0.39631322	2.2326416	6	13	31.28887
121.31	0.62108102	1.7551519	10	15	30.10174
141.28	1.20927797	1.6936286	25	1	39.75624
157.26	0.89176583	1.7436656	17	5	36.95181
163.9	1.19833464	1.0993106	24	27	21.41747
221.19	0.48765291	1.7347850	8	26	22.98480
233.11	0.28677206	2.6102708	4	17	28.66655
235.6	1.01971997	1.7309273	21	4	38.63477
241.2	0.45406877	1.9170753	7	22	26.34039
255.7	0.90124720	1.5305578	19	14	30.58975
314.12	0.78962523	1.5271379	12	18	28.17335
317.6	0.59211183	1.9633384	9	9	35.32583
319.20	1.81826161	1.5279859	27	3	38.75767
320.16	0.89897900	1.3936010	18	21	26.34808
342.15	0.79099371	1.4556573	13	24	26.01336
346.2	1.40292793	1.1198795	26	25	23.84175
351.26	0.80654291	1.7733422	14	8	36.11581
364.21	0.19598368	3.5623227	2	10	34.05974
402.7	0.07583976	7.2317748	1	19	27.47748
405.2	1.07822942	1.3907733	23	16	28.98663
406.12	0.69418710	1.7578467	11	12	32.68323
427.7	0.31056699	2.7272047	5	7	36.19020
450.3	0.85094150	1.7448731	16	6	36.19602
506.2	0.20336120	3.4475042	3	11	33.26623
Canchan	0.83849670	1.4534532	15	20	27.00126
Desiree	2.10698168	0.7548219	28	28	16.15569
Unica	1.03956820	1.7372299	22	2	39.10400

```

# Changing the ratio of weights for Rao's SSI
ASI.AMMI(model, ssi.method = "rao", a = 0.43)

```

	ASI	SSI	rASI	rY	means
102.18	0.91512303	1.0839450	20	23	26.31947
104.22	0.39631322	1.5415455	6	13	31.28887
121.31	0.62108102	1.3141619	10	15	30.10174
141.28	1.20927797	1.4671376	25	1	39.75624
157.26	0.89176583	1.4365328	17	5	36.95181

163.9	1.19833464	0.8707513	24	27	21.41747
221.19	0.48765291	1.1731344	8	26	22.98480
233.11	0.28677206	1.6551898	4	17	28.66655
235.6	1.01971997	1.4623334	21	4	38.63477
241.2	0.45406877	1.3138836	7	22	26.34039
255.7	0.90124720	1.2266562	19	14	30.58975
314.12	0.78962523	1.1802765	12	18	28.17335
317.6	0.59211183	1.5007728	9	9	35.32583
319.20	1.81826161	1.3773527	27	3	38.75767
320.16	0.89897900	1.0889326	18	21	26.34808
342.15	0.79099371	1.1093959	13	24	26.01336
346.2	1.40292793	0.9246517	26	25	23.84175
351.26	0.80654291	1.4337564	14	8	36.11581
364.21	0.19598368	2.1648057	2	10	34.05974
402.7	0.07583976	3.6203374	1	19	27.47748
405.2	1.07822942	1.1367545	23	16	28.98663
406.12	0.69418710	1.3632981	11	12	32.68323
427.7	0.31056699	1.8452998	5	7	36.19020
450.3	0.85094150	1.4230055	16	6	36.19602
506.2	0.20336120	2.1006861	3	11	33.26623
Canchan	0.83849670	1.1268084	15	20	27.00126
Desiree	2.10698168	0.6248300	28	28	16.15569
Unica	1.03956820	1.4737642	22	2	39.10400

```
# With default n (N') and default ssi.method (farshadfar)
```

```
ASTAB.AMMI(model)
```

```
ASTAB.AMMI()
```

	ASTAB	SSI	rASTAB	rY	means
102.18	3.89636621	39	16	23	26.31947
104.22	2.19372771	21	8	13	31.28887
121.31	3.87988776	29	14	15	30.10174
141.28	7.24523520	23	22	1	39.75624
157.26	11.05196482	31	26	5	36.95181
163.9	4.64005014	46	19	27	21.41747
221.19	1.52227265	30	4	26	22.98480
233.11	2.18330553	24	7	17	28.66655
235.6	10.03128021	28	24	4	38.63477
241.2	1.65890425	27	5	22	26.34039
255.7	4.50083178	32	18	14	30.58975
314.12	2.58839912	27	9	18	28.17335
317.6	1.77133006	15	6	9	35.32583
319.20	14.26494686	30	27	3	38.75767
320.16	3.13335427	32	11	21	26.34808
342.15	3.16217247	36	12	24	26.01336
346.2	7.47744386	48	23	25	23.84175
351.26	7.10182225	29	21	8	36.11581
364.21	0.27632429	12	2	10	34.05974
402.7	0.02344768	20	1	19	27.47748
405.2	4.07390905	33	17	16	28.98663
406.12	3.88758910	27	15	12	32.68323
427.7	1.43512423	10	3	7	36.19020
450.3	3.56798827	19	13	6	36.19602

```
506.2    2.71214267  21    10 11 33.26623
Canchan  5.13246683  40    20 20 27.00126
Desiree 16.47021287  56    28 28 16.15569
Unica    10.49672952  27    25  2 39.10400
```

```
# With n = 4 and default ssi.method (farshadfar)
ASTAB.AMMI(model, n = 4)
```

	ASTAB	SSI	rASTAB	rY	means
102.18	4.1339139	36	13	23	26.31947
104.22	2.3887379	21	8	13	31.28887
121.31	8.8192568	38	23	15	30.10174
141.28	7.3090299	22	21	1	39.75624
157.26	14.9147148	31	26	5	36.95181
163.9	4.8975417	45	18	27	21.41747
221.19	1.5353874	29	3	26	22.98480
233.11	2.2356017	24	7	17	28.66655
235.6	11.0719467	29	25	4	38.63477
241.2	1.7489308	27	5	22	26.34039
255.7	4.6032909	30	16	14	30.58975
314.12	2.5919840	27	9	18	28.17335
317.6	2.1098263	15	6	9	35.32583
319.20	15.5173080	30	27	3	38.75767
320.16	4.8783163	38	17	21	26.34808
342.15	4.4168665	39	15	24	26.01336
346.2	8.3050795	47	22	25	23.84175
351.26	7.1030587	28	20	8	36.11581
364.21	0.8834847	12	2	10	34.05974
402.7	0.1536666	20	1	19	27.47748
405.2	4.3356781	30	14	16	28.98663
406.12	4.0365553	24	12	12	32.68323
427.7	1.7169781	11	4	7	36.19020
450.3	3.9433912	17	11	6	36.19602
506.2	2.7143137	21	10	11	33.26623
Canchan	5.1384242	39	19	20	27.00126
Desiree	16.4723733	56	28	28	16.15569
Unica	10.9110354	26	24	2	39.10400

```
# With default n (N') and ssi.method = "rao"
ASTAB.AMMI(model, ssi.method = "rao")
```

	ASTAB	SSI	rASTAB	rY	means
102.18	3.89636621	0.9916073	16	23	26.31947
104.22	2.19372771	1.2572096	8	13	31.28887
121.31	3.87988776	1.1154972	14	15	30.10174
141.28	7.24523520	1.3680406	22	1	39.75624
157.26	11.05196482	1.2518822	26	5	36.95181
163.9	4.64005014	0.8103867	19	27	21.41747
221.19	1.52227265	1.0909958	4	26	22.98480
233.11	2.18330553	1.1728390	7	17	28.66655
235.6	10.03128021	1.3115430	24	4	38.63477
241.2	1.65890425	1.1722749	5	22	26.34039
255.7	4.50083178	1.1129205	18	14	30.58975
314.12	2.58839912	1.1194868	9	18	28.17335
317.6	1.77133006	1.4453573	6	9	35.32583

```

319.20 14.26494686 1.3001667 27 3 38.75767
320.16 3.13335427 1.0250358 11 21 26.34808
342.15 3.16217247 1.0126098 12 24 26.01336
346.2 7.47744386 0.8469106 23 25 23.84175
351.26 7.10182225 1.2507915 21 8 36.11581
364.21 0.27632429 2.9922101 2 10 34.05974
402.7 0.02344768 23.0708927 1 19 27.47748
405.2 4.07390905 1.0727560 17 16 28.98663
406.12 3.88758910 1.1994027 15 12 32.68323
427.7 1.43512423 1.5423074 3 7 36.19020
450.3 3.56798827 1.3259199 13 6 36.19602
506.2 2.71214267 1.2763780 10 11 33.26623
Canchan 5.13246683 0.9816986 20 20 27.00126
Desiree 16.47021287 0.5583351 28 28 16.15569
Unica 10.49672952 1.3245441 25 2 39.10400

```

```

# Changing the ratio of weights for Rao's SSI
ASTAB.AMMI(model, ssi.method = "rao", a = 0.43)

```

```

          ASTAB          SSI rASTAB rY      means
102.18 3.89636621 0.9155436 16 23 26.31947
104.22 2.19372771 1.1221097 8 13 31.28887
121.31 3.87988776 1.0391104 14 15 30.10174
141.28 7.24523520 1.3271348 22 1 39.75624
157.26 11.05196482 1.2250659 26 5 36.95181
163.9 4.64005014 0.7465140 19 27 21.41747
221.19 1.52227265 0.8963051 4 26 22.98480
233.11 2.18330553 1.0370941 7 17 28.66655
235.6 10.03128021 1.2819982 24 4 38.63477
241.2 1.65890425 0.9936194 5 22 26.34039
255.7 4.50083178 1.0470721 18 14 30.58975
314.12 2.58839912 1.0049865 9 18 28.17335
317.6 1.77133006 1.2780410 6 9 35.32583
319.20 14.26494686 1.2793904 27 3 38.75767
320.16 3.13335427 0.9304495 11 21 26.34808
342.15 3.16217247 0.9188855 12 24 26.01336
346.2 7.47744386 0.8072751 23 25 23.84175
351.26 7.10182225 1.2090596 21 8 36.11581
364.21 0.27632429 1.9196572 2 10 34.05974
402.7 0.02344768 10.4311581 1 19 27.47748
405.2 4.07390905 1.0000071 17 16 28.98663
406.12 3.88758910 1.1231672 15 12 32.68323
427.7 1.43512423 1.3357940 3 7 36.19020
450.3 3.56798827 1.2428556 13 6 36.19602
506.2 2.71214267 1.1671018 10 11 33.26623
Canchan 5.13246683 0.9239540 20 20 27.00126
Desiree 16.47021287 0.5403407 28 28 16.15569
Unica 10.49672952 1.2963093 25 2 39.10400

```

```

# With default n (N') and default ssi.method (farshadfar)
AVAMGE.AMMI(model)

```

```
AVAMGE.AMMI()
```

```
AVAMGE SSI rAVAMGE rY      means
```


102.18	30.229771	40	17	23	26.31947
104.22	21.584579	21	8	13	31.28887
121.31	27.893984	28	13	15	30.10174
141.28	40.486706	24	23	1	39.75624
157.26	44.055803	29	24	5	36.95181
163.9	39.056228	48	21	27	21.41747
221.19	17.905975	33	7	26	22.98480
233.11	16.242635	21	4	17	28.66655
235.6	39.840739	26	22	4	38.63477
241.2	17.101113	28	6	22	26.34039
255.7	29.306918	29	15	14	30.58975
314.12	28.760304	32	14	18	28.17335
317.6	22.700856	18	9	9	35.32583
319.20	55.232023	30	27	3	38.75767
320.16	30.717681	40	19	21	26.34808
342.15	25.538281	34	10	24	26.01336
346.2	46.236590	50	25	25	23.84175
351.26	30.105573	24	16	8	36.11581
364.21	6.742386	12	2	10	34.05974
402.7	2.202291	20	1	19	27.47748
405.2	35.890684	36	20	16	28.98663
406.12	27.272847	24	12	12	32.68323
427.7	16.756971	12	5	7	36.19020
450.3	25.628188	17	11	6	36.19602
506.2	15.760611	14	3	11	33.26623
Canchan	30.515224	38	18	20	27.00126
Desiree	69.096357	56	28	28	16.15569
Unica	47.204593	28	26	2	39.10400

```
# With n = 4 and default ssi.method (farshadfar)
AVAMGE.AMMI(model, n = 4)
```

	AVAMGE	SSI	rAVAMGE	rY	means
102.18	30.431550	39	16	23	26.31947
104.22	21.176775	21	8	13	31.28887
121.31	34.844853	34	19	15	30.10174
141.28	40.382139	24	23	1	39.75624
157.26	49.421992	31	26	5	36.95181
163.9	38.846149	48	21	27	21.41747
221.19	17.858564	33	7	26	22.98480
233.11	17.449539	23	6	17	28.66655
235.6	39.657410	26	22	4	38.63477
241.2	17.225331	27	5	22	26.34039
255.7	29.585043	28	14	14	30.58975
314.12	28.801567	31	13	18	28.17335
317.6	23.101824	18	9	9	35.32583
319.20	55.695327	30	27	3	38.75767
320.16	31.566364	39	18	21	26.34808
342.15	26.310253	35	11	24	26.01336
346.2	46.863568	50	25	25	23.84175
351.26	29.920025	23	15	8	36.11581
364.21	9.635146	12	2	10	34.05974
402.7	3.665565	20	1	19	27.47748
405.2	35.538076	36	20	16	28.98663
406.12	26.916422	24	12	12	32.68323

```

427.7  16.266701  11      4  7 36.19020
450.3  25.622916  16      10 6 36.19602
506.2  15.709209  14      3 11 33.26623
Canchan 30.908627  37      17 20 27.00126
Desiree 69.115600 56      28 28 16.15569
Unica  46.610186  26      24  2 39.10400

```

```

# With default n (N') and ssi.method = "rao"
AVAMGE.AMMI(model, ssi.method = "rao")

```

	AVAMGE	SSI	rAVAMGE	rY	means
102.18	30.229771	1.4579240	17	23	26.31947
104.22	21.584579	1.8601746	8	13	31.28887
121.31	27.893984	1.6314700	13	15	30.10174
141.28	40.486706	1.7440938	23	1	39.75624
157.26	44.055803	1.6163747	24	5	36.95181
163.9	39.056228	1.1625489	21	27	21.41747
221.19	17.905975	1.7619814	7	26	22.98480
233.11	16.242635	2.0509293	4	17	28.66655
235.6	39.840739	1.7147885	22	4	38.63477
241.2	17.101113	1.9190480	6	22	26.34039
255.7	29.306918	1.6160450	15	14	30.58975
314.12	28.760304	1.5490150	14	18	28.17335
317.6	22.700856	1.9504975	9	9	35.32583
319.20	55.232023	1.5919808	27	3	38.75767
320.16	30.717681	1.4493304	19	21	26.34808
342.15	25.538281	1.5581219	10	24	26.01336
346.2	46.236590	1.1695027	25	25	23.84175
351.26	30.105573	1.7798138	16	8	36.11581
364.21	6.742386	3.7995961	2	10	34.05974
402.7	2.202291	9.1285592	1	19	27.47748
405.2	35.890684	1.4502899	20	16	28.98663
406.12	27.272847	1.7304443	12	12	32.68323
427.7	16.756971	2.2619806	5	7	36.19020
450.3	25.628188	1.8876432	11	6	36.19602
506.2	15.760611	2.2350438	3	11	33.26623
Canchan	30.515224	1.4745437	18	20	27.00126
Desiree	69.096357	0.7891628	28	28	16.15569
Unica	47.204593	1.6590963	26	2	39.10400

```

# Changing the ratio of weights for Rao's SSI
AVAMGE.AMMI(model, ssi.method = "rao", a = 0.43)

```

	AVAMGE	SSI	rAVAMGE	rY	means
102.18	30.229771	1.1160597	17	23	26.31947
104.22	21.584579	1.3813847	8	13	31.28887
121.31	27.893984	1.2609787	13	15	30.10174
141.28	40.486706	1.4888376	23	1	39.75624
157.26	44.055803	1.3817977	24	5	36.95181
163.9	39.056228	0.8979438	21	27	21.41747
221.19	17.905975	1.1848289	7	26	22.98480
233.11	16.242635	1.4146730	4	17	28.66655
235.6	39.840739	1.4553938	22	4	38.63477
241.2	17.101113	1.3147318	6	22	26.34039
255.7	29.306918	1.2634156	15	14	30.58975
314.12	28.760304	1.1896837	14	18	28.17335

317.6	22.700856	1.4952513	9	9	35.32583
319.20	55.232023	1.4048705	27	3	38.75767
320.16	30.717681	1.1128962	19	21	26.34808
342.15	25.538281	1.1534557	10	24	26.01336
346.2	46.236590	0.9459897	25	25	23.84175
351.26	30.105573	1.4365392	16	8	36.11581
364.21	6.742386	2.2668332	2	10	34.05974
402.7	2.202291	4.4359547	1	19	27.47748
405.2	35.890684	1.1623466	20	16	28.98663
406.12	27.272847	1.3515151	12	12	32.68323
427.7	16.756971	1.6452535	5	7	36.19020
450.3	25.628188	1.4843966	11	6	36.19602
506.2	15.760611	1.5793281	3	11	33.26623
Canchan	30.515224	1.1358773	18	20	27.00126
Desiree	69.096357	0.6395966	28	28	16.15569
Unica	47.204593	1.4401668	26	2	39.10400

```
# With default n (N') and default ssi.method (farshadfar)
DA.AMMI(model)
```

```
DA.AMMI()
```

	DA	SSI	rDA	rY	means
102.18	15.040431	39	16	23	26.31947
104.22	9.798867	22	9	13	31.28887
121.31	12.917859	26	11	15	30.10174
141.28	19.659222	23	22	1	39.75624
157.26	21.459064	29	24	5	36.95181
163.9	17.499098	48	21	27	21.41747
221.19	8.507426	31	5	26	22.98480
233.11	8.981297	24	7	17	28.66655
235.6	21.941275	29	25	4	38.63477
241.2	8.453875	26	4	22	26.34039
255.7	15.423064	32	18	14	30.58975
314.12	12.222308	28	10	18	28.17335
317.6	9.592839	17	8	9	35.32583
319.20	28.986374	30	27	3	38.75767
320.16	13.835583	34	13	21	26.34808
342.15	13.025230	36	12	24	26.01336
346.2	21.230207	48	23	25	23.84175
351.26	17.269543	28	20	8	36.11581
364.21	3.781576	12	2	10	34.05974
402.7	1.191312	20	1	19	27.47748
405.2	16.027557	35	19	16	28.98663
406.12	13.989359	26	14	12	32.68323
427.7	7.507408	10	3	7	36.19020
450.3	14.270920	21	15	6	36.19602
506.2	8.954538	17	6	11	33.26623
Canchan	15.138085	37	17	20	27.00126
Desiree	32.114860	56	28	28	16.15569
Unica	22.343936	28	26	2	39.10400

```
# With n = 4 and default ssi.method (farshadfar)
DA.AMMI(model, n = 4)
```

	DA	SSI	rDA	rY	means
102.18	15.185880	39	16	23	26.31947
104.22	9.981329	22	9	13	31.28887
121.31	16.071287	33	18	15	30.10174
141.28	19.689228	23	22	1	39.75624
157.26	23.064716	31	26	5	36.95181
163.9	17.634737	48	21	27	21.41747
221.19	8.521680	30	4	26	22.98480
233.11	9.035019	24	7	17	28.66655
235.6	22.375871	28	24	4	38.63477
241.2	8.551852	27	5	22	26.34039
255.7	15.484417	31	17	14	30.58975
314.12	12.225021	28	10	18	28.17335
317.6	9.913993	17	8	9	35.32583
319.20	29.383463	30	27	3	38.75767
320.16	14.957211	35	14	21	26.34808
342.15	13.888046	35	11	24	26.01336
346.2	21.587939	48	23	25	23.84175
351.26	17.270205	28	20	8	36.11581
364.21	5.053446	12	2	10	34.05974
402.7	1.956846	20	1	19	27.47748
405.2	16.177987	35	19	16	28.98663
406.12	14.087553	24	12	12	32.68323
427.7	7.847138	10	3	7	36.19020
450.3	14.512302	19	13	6	36.19602
506.2	8.956781	17	6	11	33.26623
Canchan	15.141726	35	15	20	27.00126
Desiree	32.115482	56	28	28	16.15569
Unica	22.514867	27	25	2	39.10400

```
# With default n (N') and ssi.method = "rao"
DA.AMMI(model, ssi.method = "rao")
```

	DA	SSI	rDA	rY	means
102.18	15.040431	1.4730947	16	23	26.31947
104.22	9.798867	1.9640618	9	13	31.28887
121.31	12.917859	1.6974593	11	15	30.10174
141.28	19.659222	1.7667347	22	1	39.75624
157.26	21.459064	1.6358359	24	5	36.95181
163.9	17.499098	1.2268624	21	27	21.41747
221.19	8.507426	1.8365835	5	26	22.98480
233.11	8.981297	1.9644804	7	17	28.66655
235.6	21.941275	1.6812376	25	4	38.63477
241.2	8.453875	1.9528811	4	22	26.34039
255.7	15.423064	1.5970737	18	14	30.58975
314.12	12.222308	1.6753281	10	18	28.17335
317.6	9.592839	2.1159612	8	9	35.32583
319.20	28.986374	1.5827930	27	3	38.75767
320.16	13.835583	1.5275780	13	21	26.34808
342.15	13.025230	1.5582533	12	24	26.01336
346.2	21.230207	1.2130205	23	25	23.84175
351.26	17.269543	1.7131362	20	8	36.11581
364.21	3.781576	3.5563052	2	10	34.05974
402.7	1.191312	8.6595018	1	19	27.47748
405.2	16.027557	1.5221857	19	16	28.98663

```

406.12 13.989359 1.7267910 14 12 32.68323
427.7 7.507408 2.4119665 3 7 36.19020
450.3 14.270920 1.8282838 15 6 36.19602
506.2 8.954538 2.1175331 6 11 33.26623
Canchan 15.138085 1.4913580 17 20 27.00126
Desiree 32.114860 0.8147588 28 28 16.15569
Unica 22.343936 1.6889406 26 2 39.10400

```

```

# Changing the ratio of weights for Rao's SSI
DA.AMMI(model, ssi.method = "rao", a = 0.43)

```

```

          DA          SSI rDA rY    means
102.18 15.040431 1.1225831 16 23 26.31947
104.22 9.798867 1.4260562 9 13 31.28887
121.31 12.917859 1.2893541 11 15 30.10174
141.28 19.659222 1.4985733 22 1 39.75624
157.26 21.459064 1.3901660 24 5 36.95181
163.9 17.499098 0.9255986 21 27 21.41747
221.19 8.507426 1.2169078 5 26 22.98480
233.11 8.981297 1.3775000 7 17 28.66655
235.6 21.941275 1.4409668 25 4 38.63477
241.2 8.453875 1.3292801 4 22 26.34039
255.7 15.423064 1.2552580 18 14 30.58975
314.12 12.222308 1.2439983 10 18 28.17335
317.6 9.592839 1.5664007 8 9 35.32583
319.20 28.986374 1.4009197 27 3 38.75767
320.16 13.835583 1.1465427 13 21 26.34808
342.15 13.025230 1.1535122 12 24 26.01336
346.2 21.230207 0.9647024 23 25 23.84175
351.26 17.269543 1.4078678 20 8 36.11581
364.21 3.781576 2.1622181 2 10 34.05974
402.7 1.191312 4.2342600 1 19 27.47748
405.2 16.027557 1.1932619 19 16 28.98663
406.12 13.989359 1.3499442 14 12 32.68323
427.7 7.507408 1.7097474 3 7 36.19020
450.3 14.270920 1.4588721 15 6 36.19602
506.2 8.954538 1.5287986 6 11 33.26623
Canchan 15.138085 1.1431075 17 20 27.00126
Desiree 32.114860 0.6506029 28 28 16.15569
Unica 22.343936 1.4529998 26 2 39.10400

```

```

# With default n (N') and default ssi.method (farshadfar)
DZ.AMMI(model)

```

```
DZ.AMMI()
```

```

          DZ SSI rDZ rY    means
102.18 0.26393535 37 14 23 26.31947
104.22 0.22971564 21 8 13 31.28887
121.31 0.32031744 34 19 15 30.10174
141.28 0.39838535 23 22 1 39.75624
157.26 0.53822924 33 28 5 36.95181
163.9 0.26659011 42 15 27 21.41747
221.19 0.19563325 29 3 26 22.98480
233.11 0.25167755 27 10 17 28.66655

```

```

235.6  0.46581370  28  24  4 38.63477
241.2  0.21481887  28   6 22 26.34039
255.7  0.30862904  31  17 14 30.58975
314.12 0.22603261  25   7 18 28.17335
317.6  0.20224771  14   5  9 35.32583
319.20 0.50675112  29  26  3 38.75767
320.16 0.23280596  30   9 21 26.34808
342.15 0.25989774  36  12 24 26.01336
346.2  0.37125512  45  20 25 23.84175
351.26 0.43805896  31  23  8 36.11581
364.21 0.07409309  12   2 10 34.05974
402.7  0.02004533  20   1 19 27.47748
405.2  0.26238837  29  13 16 28.98663
406.12 0.28179394  28  16 12 32.68323
427.7  0.20176581  11   4  7 36.19020
450.3  0.25465368  17  11  6 36.19602
506.2  0.30899851  29  18 11 33.26623
Canchan 0.37201039  41  21 20 27.00126
Desiree 0.52005815  55  27 28 16.15569
Unica  0.48083049  27  25  2 39.10400

```

```
# With n = 4 and default ssi.method (farshadfar)
```

```
DZ.AMMI(model, n = 4)
```

```

                DZ SSI rDZ rY   means
102.18 0.28722309  33  10 23 26.31947
104.22 0.25160706  21   8 13 31.28887
121.31 0.60785568  42  27 15 30.10174
141.28 0.40268829  21  20  1 39.75624
157.26 0.70597721  33  28  5 36.95181
163.9  0.29151868  39  12 27 21.41747
221.19 0.19743603  29   3 26 22.98480
233.11 0.25722999  26   9 17 28.66655
235.6  0.52269682  29  25  4 38.63477
241.2  0.22585722  26   4 22 26.34039
255.7  0.31747123  30  16 14 30.58975
314.12 0.22646067  23   5 18 28.17335
317.6  0.24329787  16   7  9 35.32583
319.20 0.56961794  29  26  3 38.75767
320.16 0.38533472  40  19 21 26.34808
342.15 0.36788692  41  17 24 26.01336
346.2  0.42725798  46  21 25 23.84175
351.26 0.43813521  30  22  8 36.11581
364.21 0.19569373  12   2 10 34.05974
402.7  0.08624291  20   1 19 27.47748
405.2  0.28808268  27  11 16 28.98663
406.12 0.29573097  26  14 12 32.68323
427.7  0.23651352  13   6  7 36.19020
450.3  0.29177451  19  13  6 36.19602
506.2  0.30918827  26  15 11 33.26623
Canchan 0.37244277  38  18 20 27.00126
Desiree 0.52017037  52  24 28 16.15569
Unica  0.50357109  25  23  2 39.10400

```

```
# With default n (N') and ssi.method = "rao"
DZ.AMMI(model, ssi.method = "rao")
```

	DZ	SSI	rDZ	rY	means
102.18	0.26393535	1.5536988	14	23	26.31947
104.22	0.22971564	1.8193399	8	13	31.28887
121.31	0.32031744	1.5545939	19	15	30.10174
141.28	0.39838535	1.7570779	22	1	39.75624
157.26	0.53822924	1.5459114	28	5	36.95181
163.9	0.26659011	1.3869397	15	27	21.41747
221.19	0.19563325	1.6878048	3	26	22.98480
233.11	0.25167755	1.6641025	10	17	28.66655
235.6	0.46581370	1.6538090	24	4	38.63477
241.2	0.21481887	1.7134093	6	22	26.34039
255.7	0.30862904	1.5922105	17	14	30.58975
314.12	0.22603261	1.7307783	7	18	28.17335
317.6	0.20224771	2.0595024	5	9	35.32583
319.20	0.50675112	1.6259792	26	3	38.75767
320.16	0.23280596	1.6476346	9	21	26.34808
342.15	0.25989774	1.5545233	12	24	26.01336
346.2	0.37125512	1.2718506	20	25	23.84175
351.26	0.43805896	1.5966462	23	8	36.11581
364.21	0.07409309	3.5881882	2	10	34.05974
402.7	0.02004533	10.0539968	1	19	27.47748
405.2	0.26238837	1.6447637	13	16	28.98663
406.12	0.28179394	1.7171135	16	12	32.68323
427.7	0.20176581	2.0898536	4	7	36.19020
450.3	0.25465368	1.9010808	11	6	36.19602
506.2	0.30899851	1.6787677	18	11	33.26623
Canchan	0.37201039	1.3738642	21	20	27.00126
Desiree	0.52005815	0.8797586	27	28	16.15569
Unica	0.48083049	1.6568004	25	2	39.10400

```
# Changing the ratio of weights for Rao's SSI
DZ.AMMI(model, ssi.method = "rao", a = 0.43)
```

	DZ	SSI	rDZ	rY	means
102.18	0.26393535	1.1572429	14	23	26.31947
104.22	0.22971564	1.3638258	8	13	31.28887
121.31	0.32031744	1.2279220	19	15	30.10174
141.28	0.39838535	1.4944208	22	1	39.75624
157.26	0.53822924	1.3514985	28	5	36.95181
163.9	0.26659011	0.9944318	15	27	21.41747
221.19	0.19563325	1.1529329	3	26	22.98480
233.11	0.25167755	1.2483375	10	17	28.66655
235.6	0.46581370	1.4291726	24	4	38.63477
241.2	0.21481887	1.2263072	6	22	26.34039
255.7	0.30862904	1.2531668	17	14	30.58975
314.12	0.22603261	1.2678419	7	18	28.17335
317.6	0.20224771	1.5421234	5	9	35.32583
319.20	0.50675112	1.4194898	26	3	38.75767
320.16	0.23280596	1.1981670	9	21	26.34808
342.15	0.25989774	1.1519083	12	24	26.01336
346.2	0.37125512	0.9899993	20	25	23.84175
351.26	0.43805896	1.3577771	23	8	36.11581

```

364.21  0.07409309 2.1759278   2 10 34.05974
402.7   0.02004533 4.8338929   1 19 27.47748
405.2   0.26238837 1.2459704  13 16 28.98663
406.12  0.28179394 1.3457828  16 12 32.68323
427.7   0.20176581 1.5712389   4  7 36.19020
450.3   0.25465368 1.4901748  11  6 36.19602
506.2   0.30899851 1.3401295  18 11 33.26623
Canchan 0.37201039 1.0925852  21 20 27.00126
Desiree 0.52005815 0.6785528  27 28 16.15569
Unica   0.48083049 1.4391795  25  2 39.10400

```

```
# With default n (N') and default ssi.method (farshadfar)
```

```
EV.AMMI(model)
```

```
EV.AMMI()
```

```

              EV SSI rEV rY    means
102.18  0.0232206231  37  14 23 26.31947
104.22  0.0175897578  21   8 13 31.28887
121.31  0.0342010876  34  19 15 30.10174
141.28  0.0529036285  23  22  1 39.75624
157.26  0.0965635719  33  28  5 36.95181
163.9   0.0236900961  42  15 27 21.41747
221.19  0.0127574566  29   3 26 22.98480
233.11  0.0211138628  27  10 17 28.66655
235.6   0.0723274691  28  24  4 38.63477
241.2   0.0153823821  28   6 22 26.34039
255.7   0.0317506280  31  17 14 30.58975
314.12  0.0170302467  25   7 18 28.17335
317.6   0.0136347120  14   5  9 35.32583
319.20  0.0855988994  29  26  3 38.75767
320.16  0.0180662044  30   9 21 26.34808
342.15  0.0225156118  36  12 24 26.01336
346.2   0.0459434537  45  20 25 23.84175
351.26  0.0639652186  31  23  8 36.11581
364.21  0.0018299284  12   2 10 34.05974
402.7   0.0001339385  20   1 19 27.47748
405.2   0.0229492190  29  13 16 28.98663
406.12  0.0264692745  28  16 12 32.68323
427.7   0.0135698145  11   4  7 36.19020
450.3   0.0216161656  17  11  6 36.19602
506.2   0.0318266934  29  18 11 33.26623
Canchan 0.0461305761  41  21 20 27.00126
Desiree 0.0901534938  55  27 28 16.15569
Unica   0.0770659860  27  25  2 39.10400

```

```
# With n = 4 and default ssi.method (farshadfar)
```

```
EV.AMMI(model, n = 4)
```

```

              EV SSI rEV rY    means
102.18  0.020624276  33  10 23 26.31947
104.22  0.015826528  21   8 13 31.28887
121.31  0.092372131  42  27 15 30.10174
141.28  0.040539465  21  20  1 39.75624
157.26  0.124600955  33  28  5 36.95181

```



```

163.9  0.021245785  39  12  27  21.41747
221.19 0.009745247  29   3  26  22.98480
233.11 0.016541818  26   9  17  28.66655
235.6  0.068302992  29  25   4  38.63477
241.2  0.012752871  26   4  22  26.34039
255.7  0.025196996  30  16  14  30.58975
314.12 0.012821109  23   5  18  28.17335
317.6  0.014798464  16   7   9  35.32583
319.20 0.081116150  29  26   3  38.75767
320.16 0.037120712  40  19  21  26.34808
342.15 0.033835196  41  17  24  26.01336
346.2  0.045637346  46  21  25  23.84175
351.26 0.047990616  30  22   8  36.11581
364.21 0.009574009  12   2  10  34.05974
402.7  0.001859460  20   1  19  27.47748
405.2  0.020747907  27  11  16  28.98663
406.12 0.021864201  26  14  12  32.68323
427.7  0.013984661  13   6   7  36.19020
450.3  0.021283092  19  13   6  36.19602
506.2  0.023899346  26  15  11  33.26623
Canchan 0.034678404  38  18  20  27.00126
Desiree 0.067644303  52  24  28  16.15569
Unica  0.063395960  25  23   2  39.10400

```

```

# With default n (N') and ssi.method = "rao"
EV.AMMI(model, ssi.method = "rao")

```

```

           EV           SSI rEV rY      means
102.18 0.0232206231 0.9920136  14 23 26.31947
104.22 0.0175897578 1.1968926   8 13 31.28887
121.31 0.0342010876 1.0723629  19 15 30.10174
141.28 0.0529036285 1.3550266  22  1 39.75624
157.26 0.0965635719 1.2370234  28  5 36.95181
163.9  0.0236900961 0.8295284  15 27 21.41747
221.19 0.0127574566 0.9930645   3 26 22.98480
233.11 0.0211138628 1.0818975  10 17 28.66655
235.6  0.0723274691 1.3026828  24  4 38.63477
241.2  0.0153823821 1.0609011   6 22 26.34039
255.7  0.0317506280 1.0952885  17 14 30.58975
314.12 0.0170302467 1.1011148   7 18 28.17335
317.6  0.0136347120 1.3797760   5  9 35.32583
319.20 0.0855988994 1.3000274  26  3 38.75767
320.16 0.0180662044 1.0311353   9 21 26.34808
342.15 0.0225156118 0.9862240  12 24 26.01336
346.2  0.0459434537 0.8450255  20 25 23.84175
351.26 0.0639652186 1.2261684  23  8 36.11581
364.21 0.0018299284 2.8090292   2 10 34.05974
402.7  0.0001339385 24.1014741   1 19 27.47748
405.2  0.0229492190 1.0805609  13 16 28.98663
406.12 0.0264692745 1.1830798  16 12 32.68323
427.7  0.0135698145 1.4090495   4  7 36.19020
450.3  0.0216161656 1.3239797  11  6 36.19602
506.2  0.0318266934 1.1823230  18 11 33.26623
Canchan 0.0461305761 0.9477687  21 20 27.00126
Desiree 0.0901534938 0.5612418  27 28 16.15569

```

```
Unica 0.0770659860 1.3153400 25 2 39.10400
```

```
# Changing the ratio of weights for Rao's SSI
```

```
EV.AMMI(model, ssi.method = "rao", a = 0.43)
```

	EV	SSI	rEV	rY	means
102.18	0.0232206231	0.9157183	14	23	26.31947
104.22	0.0175897578	1.0961734	8	13	31.28887
121.31	0.0342010876	1.0205626	19	15	30.10174
141.28	0.0529036285	1.3215387	22	1	39.75624
157.26	0.0965635719	1.2186766	28	5	36.95181
163.9	0.0236900961	0.7547449	15	27	21.41747
221.19	0.0127574566	0.8541946	3	26	22.98480
233.11	0.0211138628	0.9979893	10	17	28.66655
235.6	0.0723274691	1.2781883	24	4	38.63477
241.2	0.0153823821	0.9457286	6	22	26.34039
255.7	0.0317506280	1.0394903	17	14	30.58975
314.12	0.0170302467	0.9970866	7	18	28.17335
317.6	0.0136347120	1.2498410	5	9	35.32583
319.20	0.0855988994	1.2793305	26	3	38.75767
320.16	0.0180662044	0.9330723	9	21	26.34808
342.15	0.0225156118	0.9075396	12	24	26.01336
346.2	0.0459434537	0.8064645	20	25	23.84175
351.26	0.0639652186	1.1984717	23	8	36.11581
364.21	0.0018299284	1.8408895	2	10	34.05974
402.7	0.0001339385	10.8743081	1	19	27.47748
405.2	0.0229492190	1.0033632	13	16	28.98663
406.12	0.0264692745	1.1161483	16	12	32.68323
427.7	0.0135698145	1.2784931	4	7	36.19020
450.3	0.0216161656	1.2420213	11	6	36.19602
506.2	0.0318266934	1.1266582	18	11	33.26623
Canchan	0.0461305761	0.9093641	21	20	27.00126
Desiree	0.0901534938	0.5415905	27	28	16.15569
Unica	0.0770659860	1.2923516	25	2	39.10400

```
# With default n (N') and default ssi.method (farshadfar)
```

```
FA.AMMI(model)
```

```
FA.AMMI()
```

	FA	SSI	rFA	rY	means
102.18	226.214559	39	16	23	26.31947
104.22	96.017789	22	9	13	31.28887
121.31	166.871081	26	11	15	30.10174
141.28	386.485026	23	22	1	39.75624
157.26	460.491413	29	24	5	36.95181
163.9	306.218437	48	21	27	21.41747
221.19	72.376305	31	5	26	22.98480
233.11	80.663694	24	7	17	28.66655
235.6	481.419528	29	25	4	38.63477
241.2	71.468008	26	4	22	26.34039
255.7	237.870912	32	18	14	30.58975
314.12	149.384801	28	10	18	28.17335
317.6	92.022551	17	8	9	35.32583
319.20	840.209886	30	27	3	38.75767

```

320.16 191.423345 34 13 21 26.34808
342.15 169.656627 36 12 24 26.01336
346.2 450.721670 48 23 25 23.84175
351.26 298.237108 28 20 8 36.11581
364.21 14.300314 12 2 10 34.05974
402.7 1.419225 20 1 19 27.47748
405.2 256.882577 35 19 16 28.98663
406.12 195.702153 26 14 12 32.68323
427.7 56.361179 10 3 7 36.19020
450.3 203.659148 21 15 6 36.19602
506.2 80.183743 17 6 11 33.26623
Canchan 229.161607 37 17 20 27.00126
Desiree 1031.364210 56 28 28 16.15569
Unica 499.251489 28 26 2 39.10400

```

```

# With n = 4 and default ssi.method (farshadfar)
FA.AMMI(model, n = 4)

```

```

                FA SSI rFA rY  means
102.18 230.610963 39 16 23 26.31947
104.22 99.626933 22 9 13 31.28887
121.31 258.286270 33 18 15 30.10174
141.28 387.665704 23 22 1 39.75624
157.26 531.981114 31 26 5 36.95181
163.9 310.983953 48 21 27 21.41747
221.19 72.619025 30 4 26 22.98480
233.11 81.631564 24 7 17 28.66655
235.6 500.679624 28 24 4 38.63477
241.2 73.134171 27 5 22 26.34039
255.7 239.767170 31 17 14 30.58975
314.12 149.451148 28 10 18 28.17335
317.6 98.287259 17 8 9 35.32583
319.20 863.387913 30 27 3 38.75767
320.16 223.718164 35 14 21 26.34808
342.15 192.877830 35 11 24 26.01336
346.2 466.039106 48 23 25 23.84175
351.26 298.259992 28 20 8 36.11581
364.21 25.537314 12 2 10 34.05974
402.7 3.829248 20 1 19 27.47748
405.2 261.727258 35 19 16 28.98663
406.12 198.459140 24 12 12 32.68323
427.7 61.577580 10 3 7 36.19020
450.3 210.606905 19 13 6 36.19602
506.2 80.223923 17 6 11 33.26623
Canchan 229.271862 35 15 20 27.00126
Desiree 1031.404193 56 28 28 16.15569
Unica 506.919240 27 25 2 39.10400

```

```

# With default n (N') and ssi.method = "rao"
FA.AMMI(model, ssi.method = "rao")

```

```

                FA          SSI rFA rY  means
102.18 226.214559 0.9902913 16 23 26.31947
104.22 96.017789 1.3314840 9 13 31.28887
121.31 166.871081 1.1606028 11 15 30.10174

```

141.28	386.485026	1.3736129	22	1	39.75624
157.26	460.491413	1.2697440	24	5	36.95181
163.9	306.218437	0.7959379	21	27	21.41747
221.19	72.376305	1.1624072	5	26	22.98480
233.11	80.663694	1.3052353	7	17	28.66655
235.6	481.419528	1.3217963	25	4	38.63477
241.2	71.468008	1.2770668	4	22	26.34039
255.7	237.870912	1.1230515	18	14	30.58975
314.12	149.384801	1.1186933	10	18	28.17335
317.6	92.022551	1.4766266	8	9	35.32583
319.20	840.209886	1.2992910	27	3	38.75767
320.16	191.423345	1.0152386	13	21	26.34808
342.15	169.656627	1.0243579	12	24	26.01336
346.2	450.721670	0.8436895	23	25	23.84175
351.26	298.237108	1.2777984	20	8	36.11581
364.21	14.300314	3.2006702	2	10	34.05974
402.7	1.419225	21.9563817	1	19	27.47748
405.2	256.882577	1.0614812	19	16	28.98663
406.12	195.702153	1.2183859	14	12	32.68323
427.7	56.361179	1.7103246	3	7	36.19020
450.3	203.659148	1.3269556	15	6	36.19602
506.2	80.183743	1.4574286	6	11	33.26623
Canchan	229.161607	1.0108222	17	20	27.00126
Desiree	1031.364210	0.5557465	28	28	16.15569
Unica	499.251489	1.3348781	26	2	39.10400

```
# Changing the ratio of weights for Rao's SSI
FA.AMMI(model, ssi.method = "rao", a = 0.43)
```

	FA	SSI	rFA	rY	means
102.18	226.214559	0.9149776	16	23	26.31947
104.22	96.017789	1.1540477	9	13	31.28887
121.31	166.871081	1.0585058	11	15	30.10174
141.28	386.485026	1.3295309	22	1	39.75624
157.26	460.491413	1.2327465	24	5	36.95181
163.9	306.218437	0.7403010	21	27	21.41747
221.19	72.376305	0.9270120	5	26	22.98480
233.11	80.663694	1.0940246	7	17	28.66655
235.6	481.419528	1.2864071	25	4	38.63477
241.2	71.468008	1.0386799	4	22	26.34039
255.7	237.870912	1.0514284	18	14	30.58975
314.12	149.384801	1.0046453	10	18	28.17335
317.6	92.022551	1.2914868	8	9	35.32583
319.20	840.209886	1.2790139	27	3	38.75767
320.16	191.423345	0.9262367	13	21	26.34808
342.15	169.656627	0.9239372	12	24	26.01336
346.2	450.721670	0.8058900	23	25	23.84175
351.26	298.237108	1.2206726	20	8	36.11581
364.21	14.300314	2.0092951	2	10	34.05974
402.7	1.419225	9.9519184	1	19	27.47748
405.2	256.882577	0.9951589	19	16	28.98663
406.12	195.702153	1.1313300	14	12	32.68323
427.7	56.361179	1.4080414	3	7	36.19020
450.3	203.659148	1.2433009	15	6	36.19602
506.2	80.183743	1.2449536	6	11	33.26623

```

Canchan 229.161607 0.9364771 17 20 27.00126
Desiree 1031.364210 0.5392276 28 28 16.15569
Unica 499.251489 1.3007530 26 2 39.10400

```

```

# With default n (N') and default ssi.method (farshadfar)
MASV.AMMI(model)

```

```
MASV.AMMI()
```

	MASV	SSI	rMASV	rY	means
102.18	4.7855876	42	19	23	26.31947
104.22	3.8328358	25	12	13	31.28887
121.31	4.0446758	29	14	15	30.10174
141.28	5.1867706	21	20	1	39.75624
157.26	7.6459224	29	24	5	36.95181
163.9	4.4977055	43	16	27	21.41747
221.19	2.1905344	31	5	26	22.98480
233.11	3.1794345	26	9	17	28.66655
235.6	8.4913020	29	25	4	38.63477
241.2	2.0338659	26	4	22	26.34039
255.7	4.7013868	32	18	14	30.58975
314.12	3.1376678	26	8	18	28.17335
317.6	2.3345492	15	6	9	35.32583
319.20	8.6398087	30	27	3	38.75767
320.16	3.8822326	34	13	21	26.34808
342.15	3.6438425	34	10	24	26.01336
346.2	5.3987165	47	22	25	23.84175
351.26	5.4005468	31	23	8	36.11581
364.21	1.4047546	12	2	10	34.05974
402.7	0.3537818	20	1	19	27.47748
405.2	4.1095727	31	15	16	28.98663
406.12	5.3218165	33	21	12	32.68323
427.7	2.4124676	14	7	7	36.19020
450.3	4.6608954	23	17	6	36.19602
506.2	1.9330143	14	3	11	33.26623
Canchan	3.6665608	31	11	20	27.00126
Desiree	9.0626072	56	28	28	16.15569
Unica	8.5447632	28	26	2	39.10400

```

# With n = 4 and default ssi.method (farshadfar)
MASV.AMMI(model, n = 4)

```

	MASV	SSI	rMASV	rY	means
102.18	4.8247593	39	16	23	26.31947
104.22	4.0510711	23	10	13	31.28887
121.31	5.2473236	34	19	15	30.10174
141.28	5.9101338	23	22	1	39.75624
157.26	8.7719153	30	25	5	36.95181
163.9	4.5459209	41	14	27	21.41747
221.19	2.7137861	29	3	26	22.98480
233.11	3.7724279	26	9	17	28.66655
235.6	8.6953084	28	24	4	38.63477
241.2	2.8067193	26	4	22	26.34039
255.7	5.0424601	32	18	14	30.58975
314.12	3.4445298	25	7	18	28.17335

```

317.6  2.8792321  14    5  9 35.32583
319.20 8.8774217  30   27  3 38.75767
320.16 4.1787768  33   12 21 26.34808
342.15 4.1725070  35   11 24 26.01336
346.2  5.8554350  46   21 25 23.84175
351.26 6.4286626  31   23  8 36.11581
364.21 1.6075453  12    2 10 34.05974
402.7  0.5067415  20    1 19 27.47748
405.2  4.2896919  29   13 16 28.98663
406.12 5.3564283  32   20 12 32.68323
427.7  2.9737174  13    6  7 36.19020
450.3  4.7112537  21   15  6 36.19602
506.2  3.6306466  19    8 11 33.26623
Canchan 4.8979104  37   17 20 27.00126
Desiree 9.1023670  56   28 28 16.15569
Unica  8.7835476  28   26  2 39.10400

```

```

# With default n (N') and ssi.method = "rao"
MASV.AMMI(model, ssi.method = "rao")

```

	MASV	SSI	rMASV	rY	means
102.18	4.7855876	1.4296717	19	23	26.31947
104.22	3.8328358	1.7337655	12	13	31.28887
121.31	4.0446758	1.6576851	14	15	30.10174
141.28	5.1867706	1.8235808	20	1	39.75624
157.26	7.6459224	1.5625443	24	5	36.95181
163.9	4.4977055	1.3064192	16	27	21.41747
221.19	2.1905344	1.9979910	5	26	22.98480
233.11	3.1794345	1.7949089	9	17	28.66655
235.6	8.4913020	1.5818054	25	4	38.63477
241.2	2.0338659	2.2035784	4	22	26.34039
255.7	4.7013868	1.5791422	18	14	30.58975
314.12	3.1376678	1.7902786	8	18	28.17335
317.6	2.3345492	2.3233562	6	9	35.32583
319.20	8.6398087	1.5802761	27	3	38.75767
320.16	3.8822326	1.5635888	13	21	26.34808
342.15	3.6438425	1.5987650	10	24	26.01336
346.2	5.3987165	1.2839782	22	25	23.84175
351.26	5.4005468	1.6840095	23	8	36.11581
364.21	1.4047546	3.0575043	2	10	34.05974
402.7	0.3537818	8.6266993	1	19	27.47748
405.2	4.1095727	1.6106479	15	16	28.98663
406.12	5.3218165	1.5795802	21	12	32.68323
427.7	2.4124676	2.3137009	7	7	36.19020
450.3	4.6608954	1.7669921	17	6	36.19602
506.2	1.9330143	2.4995588	3	11	33.26623
Canchan	3.6665608	1.6263253	11	20	27.00126
Desiree	9.0626072	0.8285565	28	28	16.15569
Unica	8.5447632	1.5950896	26	2	39.10400

```

# Changing the ratio of weights for Rao's SSI
MASV.AMMI(model, ssi.method = "rao", a = 0.43)

```

	MASV	SSI	rMASV	rY	means
102.18	4.7855876	1.1039112	19	23	26.31947
104.22	3.8328358	1.3270288	12	13	31.28887

121.31	4.0446758	1.2722512	14	15	30.10174
141.28	5.1867706	1.5230171	20	1	39.75624
157.26	7.6459224	1.3586506	24	5	36.95181
163.9	4.4977055	0.9598080	16	27	21.41747
221.19	2.1905344	1.2863130	5	26	22.98480
233.11	3.1794345	1.3045842	9	17	28.66655
235.6	8.4913020	1.3982110	25	4	38.63477
241.2	2.0338659	1.4370799	4	22	26.34039
255.7	4.7013868	1.2475474	18	14	30.58975
314.12	3.1376678	1.2934270	8	18	28.17335
317.6	2.3345492	1.6555805	6	9	35.32583
319.20	8.6398087	1.3998375	27	3	38.75767
320.16	3.8822326	1.1620273	13	21	26.34808
342.15	3.6438425	1.1709323	10	24	26.01336
346.2	5.3987165	0.9952142	22	25	23.84175
351.26	5.4005468	1.3953434	23	8	36.11581
364.21	1.4047546	1.9477337	2	10	34.05974
402.7	0.3537818	4.2201550	1	19	27.47748
405.2	4.1095727	1.2313006	15	16	28.98663
406.12	5.3218165	1.2866435	21	12	32.68323
427.7	2.4124676	1.6674932	7	7	36.19020
450.3	4.6608954	1.4325166	17	6	36.19602
506.2	1.9330143	1.6930696	3	11	33.26623
Canchan	3.6665608	1.2011435	11	20	27.00126
Desiree	9.0626072	0.6565359	28	28	16.15569
Unica	8.5447632	1.4126439	26	2	39.10400

```
# With default n (N') and default ssi.method (farshadfar)
SIPC.AMMI(model)
```

```
SIPC.AMMI()
```

	SIPC	SSI	rSIPC	rY	means
102.18	2.9592568	39	16	23	26.31947
104.22	2.2591593	22	9	13	31.28887
121.31	3.3872806	33	18	15	30.10174
141.28	4.3846248	23	22	1	39.75624
157.26	5.4846596	31	26	5	36.95181
163.9	2.6263670	38	11	27	21.41747
221.19	2.0218098	32	6	26	22.98480
233.11	2.1624442	24	7	17	28.66655
235.6	4.8273551	28	24	4	38.63477
241.2	2.0056410	27	5	22	26.34039
255.7	3.6075128	34	20	14	30.58975
314.12	2.4584089	28	10	18	28.17335
317.6	1.8698826	12	3	9	35.32583
319.20	5.9590451	31	28	3	38.75767
320.16	2.7040109	33	12	21	26.34808
342.15	2.9755899	41	17	24	26.01336
346.2	3.9525017	46	21	25	23.84175
351.26	4.5622439	31	23	8	36.11581
364.21	0.7526264	12	2	10	34.05974
402.7	0.2284995	20	1	19	27.47748
405.2	2.7952381	29	13	16	28.98663

```

406.12  2.8834753  27    15 12 32.68323
427.7   2.0049278  11     4  7 36.19020
450.3   2.8200387  20    14  6 36.19602
506.2   2.2178470  19     8 11 33.26623
Canchan 3.5328212  39    19 20 27.00126
Desiree 5.8073242  55    27 28 16.15569
Unica   5.0654615  27    25  2 39.10400

```

```

# With n = 4 and default ssi.method (farshadfar)
SIPC.AMMI(model, n = 4)

```

```

          SIPC SSI rSIPC rY    means
102.18  3.4466455  38    15 23 26.31947
104.22  2.7007589  23    10 13 31.28887
121.31  5.6097497  38    23 15 30.10174
141.28  4.6372010  22    21  1 39.75624
157.26  7.4500476  33    28  5 36.95181
163.9   3.1338033  38    11 27 21.41747
221.19  2.1363292  29     3 26 22.98480
233.11  2.3911278  23     6 17 28.66655
235.6   5.8474857  29    25  4 38.63477
241.2   2.3056852  27     5 22 26.34039
255.7   3.9276052  31    17 14 30.58975
314.12  2.5182824  26     8 18 28.17335
317.6   2.4516869  16     7  9 35.32583
319.20  7.0781345  30    27  3 38.75767
320.16  4.0249810  39    18 21 26.34808
342.15  4.0957211  43    19 24 26.01336
346.2   4.8622465  47    22 25 23.84175
351.26  4.5974075  28    20  8 36.11581
364.21  1.5318314  12     2 10 34.05974
402.7   0.5893581  20     1 19 27.47748
405.2   3.3068718  29    13 16 28.98663
406.12  3.2694367  24    12 12 32.68323
427.7   2.5358269  16     9  7 36.19020
450.3   3.4327401  20    14  6 36.19602
506.2   2.2644412  15     4 11 33.26623
Canchan 3.6100050  36    16 20 27.00126
Desiree 5.8538044  54    26 28 16.15569
Unica   5.7091275  26    24  2 39.10400

```

```

# With default n (N') and ssi.method = "rao"
SIPC.AMMI(model, ssi.method = "rao")

```

```

          SIPC      SSI rSIPC rY    means
102.18  2.9592568 1.5124653   16 23 26.31947
104.22  2.2591593 1.8772594    9 13 31.28887
121.31  3.3872806 1.5531093   18 15 30.10174
141.28  4.3846248 1.7378762   22  1 39.75624
157.26  5.4846596 1.5578664   26  5 36.95181
163.9   2.6263670 1.4355650   11 27 21.41747
221.19  2.0218098 1.7071153    6 26 22.98480
233.11  2.1624442 1.8300896    7 17 28.66655
235.6   4.8273551 1.6608098   24  4 38.63477
241.2   2.0056410 1.8242469    5 22 26.34039

```



```

255.7  3.6075128 1.5341245    20 14 30.58975
314.12 2.4584089 1.7062126    10 18 28.17335
317.6  1.8698826 2.1873134     3  9 35.32583
319.20 5.9590451 1.5886436    28  3 38.75767
320.16 2.7040109 1.5751613    12 21 26.34808
342.15 2.9755899 1.4988930    17 24 26.01336
346.2  3.9525017 1.2672546    21 25 23.84175
351.26 4.5622439 1.6019853    23  8 36.11581
364.21 0.7526264 3.6831976     2 10 34.05974
402.7  0.2284995 9.3696848     1 19 27.47748
405.2  2.7952381 1.6378227    13 16 28.98663
406.12 2.8834753 1.7371554    15 12 32.68323
427.7  2.0049278 2.1457493     4  7 36.19020
450.3  2.8200387 1.8667975    14  6 36.19602
506.2  2.2178470 1.9576974     8 11 33.26623
Canchan 3.5328212 1.4284673    19 20 27.00126
Desiree 5.8073242 0.8601813    27 28 16.15569
Unica  5.0654615 1.6572552    25  2 39.10400

```

```

# Changing the ratio of weights for Rao's SSI
SIPC.AMMI(model, ssi.method = "rao", a = 0.43)

```

```

          SIPC      SSI rSIPC rY    means
102.18 2.9592568 1.1395125    16 23 26.31947
104.22 2.2591593 1.3887312     9 13 31.28887
121.31 3.3872806 1.2272836    18 15 30.10174
141.28 4.3846248 1.4861641    22  1 39.75624
157.26 5.4846596 1.3566391    26  5 36.95181
163.9  2.6263670 1.0153407    11 27 21.41747
221.19 2.0218098 1.1612364     6 26 22.98480
233.11 2.1624442 1.3197119     7 17 28.66655
235.6  4.8273551 1.4321829    24  4 38.63477
241.2  2.0056410 1.2739673     5 22 26.34039
255.7  3.6075128 1.2281898    20 14 30.58975
314.12 2.4584089 1.2572786    10 18 28.17335
317.6  1.8698826 1.5970821     3  9 35.32583
319.20 5.9590451 1.4034355    28  3 38.75767
320.16 2.7040109 1.1670035    12 21 26.34808
342.15 2.9755899 1.1279873    17 24 26.01336
346.2  3.9525017 0.9880230    21 25 23.84175
351.26 4.5622439 1.3600729    23  8 36.11581
364.21 0.7526264 2.2167818     2 10 34.05974
402.7  0.2284995 4.5396387     1 19 27.47748
405.2  2.7952381 1.2429858    13 16 28.98663
406.12 2.8834753 1.3544008    15 12 32.68323
427.7  2.0049278 1.5952740     4  7 36.19020
450.3  2.8200387 1.4754330    14  6 36.19602
506.2  2.2178470 1.4600692     8 11 33.26623
Canchan 3.5328212 1.1160645    19 20 27.00126
Desiree 5.8073242 0.6701345    27 28 16.15569
Unica  5.0654615 1.4393751    25  2 39.10400

```

```

# With default n (N') and default ssi.method (farshadfar)
ZA.AMMI(model)

```

```
ZA.AMMI()
```

```

      Za SSI rZa rY    means
102.18 0.15752787 41 18 23 26.31947
104.22 0.08552245 20  7 13 31.28887
121.31 0.13457796 26 11 15 30.10174
141.28 0.20424009 23 22  1 39.75624
157.26 0.20593889 28 23  5 36.95181
163.9  0.16161024 46 19 27 21.41747
221.19 0.08723440 34  8 26 22.98480
233.11 0.06559491 21  4 17 28.66655
235.6  0.20950908 29 25  4 38.63477
241.2  0.08160010 28  6 22 26.34039
255.7  0.16694984 34 20 14 30.58975
314.12 0.12243347 28 10 18 28.17335
317.6  0.08723605 18  9  9 35.32583
319.20 0.30778801 30 27  3 38.75767
320.16 0.14393358 35 14 21 26.34808
342.15 0.13891478 37 13 24 26.01336
346.2  0.20627243 49 24 25 23.84175
351.26 0.17809076 29 21  8 36.11581
364.21 0.03723882 12  2 10 34.05974
402.7  0.01243185 20  1 19 27.47748
405.2  0.15425031 33 17 16 28.98663
406.12 0.13595705 24 12 12 32.68323
427.7  0.07364374 12  5  7 36.19020
450.3  0.14895835 22 16  6 36.19602
506.2  0.06332050 14  3 11 33.26623
Canchan 0.14710608 35 15 20 27.00126
Desiree 0.32787182 56 28 28 16.15569
Unica   0.21646330 28 26  2 39.10400

```

```
# With n = 4 and default ssi.method (farshadfar)
ZA.AMMI(model, n = 4)
```

```

      Za SSI rZa rY    means
102.18 0.16239946 41 18 23 26.31947
104.22 0.08993636 21  8 13 31.28887
121.31 0.15679216 30 15 15 30.10174
141.28 0.20676466 23 22  1 39.75624
157.26 0.22558350 31 26  5 36.95181
163.9  0.16668221 46 19 27 21.41747
221.19 0.08837906 33  7 26 22.98480
233.11 0.06788066 21  4 17 28.66655
235.6  0.21970557 28 24  4 38.63477
241.2  0.08459913 28  6 22 26.34039
255.7  0.17014926 34 20 14 30.58975
314.12 0.12303192 28 10 18 28.17335
317.6  0.09305134 18  9  9 35.32583
319.20 0.31897363 30 27  3 38.75767
320.16 0.15713705 37 16 21 26.34808
342.15 0.15011080 37 13 24 26.01336
346.2  0.21536559 48 23 25 23.84175
351.26 0.17844223 29 21  8 36.11581
364.21 0.04502719 12  2 10 34.05974

```

```

402.7  0.01603874  20  1 19 27.47748
405.2  0.15936424  33 17 16 28.98663
406.12 0.13981485  23 11 12 32.68323
427.7  0.07895023  12  5  7 36.19020
450.3  0.15508247  20 14  6 36.19602
506.2  0.06378622  14  3 11 33.26623
Canchan 0.14787755  32 12 20 27.00126
Desiree 0.32833640 56 28 28 16.15569
Unica  0.22289692  27 25  2 39.10400

```

```

# With default n (N') and ssi.method = "rao"
ZA.AMMI(model, ssi.method = "rao")

```

```

          Za      SSI rZa rY    means
102.18  0.15752787 1.4309653 18 23 26.31947
104.22  0.08552245 2.0752658  7 13 31.28887
121.31  0.13457796 1.6519700 11 15 30.10174
141.28  0.20424009 1.7380721 22  1 39.75624
157.26  0.20593889 1.6429878 23  5 36.95181
163.9   0.16161024 1.2566633 19 27 21.41747
221.19  0.08723440 1.7838011  8 26 22.98480
233.11  0.06559491 2.3102920  4 17 28.66655
235.6   0.20950908 1.6903953 25  4 38.63477
241.2   0.08160010 1.9646329  6 22 26.34039
255.7   0.16694984 1.5378736 20 14 30.58975
314.12  0.12243347 1.6556010 10 18 28.17335
317.6   0.08723605 2.1861684  9  9 35.32583
319.20  0.30778801 1.5568815 27  3 38.75767
320.16  0.14393358 1.4859985 14 21 26.34808
342.15  0.13891478 1.4977340 13 24 26.01336
346.2   0.20627243 1.2148178 24 25 23.84175
351.26  0.17809076 1.6842433 21  8 36.11581
364.21  0.03723882 3.5336141  2 10 34.05974
402.7   0.01243185 8.1540882  1 19 27.47748
405.2   0.15425031 1.5301007 17 16 28.98663
406.12  0.13595705 1.7293399 12 12 32.68323
427.7   0.07364374 2.4052596  5  7 36.19020
450.3   0.14895835 1.7859494 16  6 36.19602
506.2   0.06332050 2.5096775  3 11 33.26623
Canchan 0.14710608 1.4937760 15 20 27.00126
Desiree 0.32787182 0.8019725 28 28 16.15569
Unica   0.21646330 1.6918583 26  2 39.10400

```

```

# Changing the ratio of weights for Rao's SSI
ZA.AMMI(model, ssi.method = "rao", a = 0.43)

```

```

          Za      SSI rZa rY    means
102.18  0.15752787 1.1044675 18 23 26.31947
104.22  0.08552245 1.4738739  7 13 31.28887
121.31  0.13457796 1.2697937 11 15 30.10174
141.28  0.20424009 1.4862483 22  1 39.75624
157.26  0.20593889 1.3932413 23  5 36.95181
163.9   0.16161024 0.9384129 19 27 21.41747
221.19  0.08723440 1.1942113  8 26 22.98480
233.11  0.06559491 1.5261989  4 17 28.66655
235.6   0.20950908 1.4449047 25  4 38.63477

```

241.2	0.08160010	1.3343333	6	22	26.34039
255.7	0.16694984	1.2298019	20	14	30.58975
314.12	0.12243347	1.2355156	10	18	28.17335
317.6	0.08723605	1.5965898	9	9	35.32583
319.20	0.30778801	1.3897778	27	3	38.75767
320.16	0.14393358	1.1286635	14	21	26.34808
342.15	0.13891478	1.1274889	13	24	26.01336
346.2	0.20627243	0.9654752	24	25	23.84175
351.26	0.17809076	1.3954439	21	8	36.11581
364.21	0.03723882	2.1524610	2	10	34.05974
402.7	0.01243185	4.0169322	1	19	27.47748
405.2	0.15425031	1.1966653	17	16	28.98663
406.12	0.13595705	1.3510402	12	12	32.68323
427.7	0.07364374	1.7068634	5	7	36.19020
450.3	0.14895835	1.4406683	16	6	36.19602
506.2	0.06332050	1.6974207	3	11	33.26623
Canchan	0.14710608	1.1441472	15	20	27.00126
Desiree	0.32787182	0.6451047	28	28	16.15569
Unica	0.21646330	1.4542544	26	2	39.10400

Simultaneous selection indices for yield and stability

The most stable genotype need not necessarily be the highest yielding genotype. Hence, simultaneous selection indices (SSIs) have been proposed for the selection of stable as well as high yielding genotypes.

A family of simultaneous selection indices (I_i) were proposed by Rao and Prabhakaran (2005) similar to those proposed by Bajpai and Prabhakaran (2000) by incorporating the AMMI Based Stability Parameter ($ASTAB$) and Yield as components. These indices consist of yield component, measured as the ratio of the average performance of the i th genotype to the overall mean performance of the genotypes under test and a stability component, measured as the ratio of stability information ($\frac{1}{ASTAB}$) of the i th genotype to the mean stability information of the genotypes under test.

$$I_i = \frac{\bar{Y}_i}{\bar{Y}_{..}} + \alpha \frac{\frac{1}{ASTAB_i}}{\frac{1}{T} \sum_{i=1}^T \frac{1}{ASTAB_i}}$$

Where $ASTAB_i$ is the stability measure of the i th genotype under AMMI procedure; Y_i is mean performance of i th genotype; $Y_{..}$ is the overall mean; T is the number of genotypes under test and α is the ratio of the weights given to the stability components (w_2) and yield (w_1) with a restriction that $w_1 + w_2 = 1$. The weights can be specified as required (Table 2).

Table 2 : α and corresponding weights (w_1 and w_2)

α	w_1	w_2
1.00	0.5	0.5
0.67	0.6	0.4
0.43	0.7	0.3
0.25	0.8	0.2

In ammistability, the above expression has been implemented for all the stability parameters (SP) including $ASTAB$.

$$I_i = \frac{\bar{Y}_i}{\bar{Y}_{..}} + \alpha \frac{\frac{1}{SP_i}}{\frac{1}{T} \sum_{i=1}^T \frac{1}{SP_i}}$$

Genotype stability index (*GSI*) (Farshadfar, 2008) or Yield stability index (*YSI*) (Farshadfar et al., 2011; Jambhulkar et al., 2017) is a simultaneous selection index for yield and yield stability which is computed by summation of the ranks of the stability index/parameter and the ranks of the mean yields. *YSI* is computed for all the stability parameters/indices implemented in this package.

$$GSI = YSI = R_{SP} + R_Y$$

Where, R_{SP} is the stability parameter/index rank of the genotype and R_Y is the mean yield rank of the genotype.

The function `SSI` implements both these indices in `ammistability`. Further, for each of the stability parameter functions, the simultaneous selection index is also computed by either of these functions as specified by the argument `ssi.method`.

Examples

```
library(agricolae)
data(plrv)
model <- with(plrv, AMMI(Locality, Genotype, Rep, Yield, console=FALSE))

yield <- aggregate(model$means$Yield, by= list(model$means$GEN),
                  FUN=mean, na.rm=TRUE)[,2]
stab <- DZ.AMMI(model)$DZ
genotypes <- rownames(DZ.AMMI(model))

# With default ssi.method (farshadfar)
SSI(y = yield, sp = stab, gen = genotypes)
```

SSI()

	SP	SSI	rSP	rY	means
102.18	0.26393535	37	14	23	26.31947
104.22	0.22971564	21	8	13	31.28887
121.31	0.32031744	34	19	15	30.10174
141.28	0.39838535	23	22	1	39.75624
157.26	0.53822924	33	28	5	36.95181
163.9	0.26659011	42	15	27	21.41747
221.19	0.19563325	29	3	26	22.98480
233.11	0.25167755	27	10	17	28.66655
235.6	0.46581370	28	24	4	38.63477
241.2	0.21481887	28	6	22	26.34039
255.7	0.30862904	31	17	14	30.58975
314.12	0.22603261	25	7	18	28.17335
317.6	0.20224771	14	5	9	35.32583
319.20	0.50675112	29	26	3	38.75767
320.16	0.23280596	30	9	21	26.34808
342.15	0.25989774	36	12	24	26.01336
346.2	0.37125512	45	20	25	23.84175
351.26	0.43805896	31	23	8	36.11581
364.21	0.07409309	12	2	10	34.05974
402.7	0.02004533	20	1	19	27.47748
405.2	0.26238837	29	13	16	28.98663
406.12	0.28179394	28	16	12	32.68323
427.7	0.20176581	11	4	7	36.19020

```
450.3 0.25465368 17 11 6 36.19602
506.2 0.30899851 29 18 11 33.26623
Canchan 0.37201039 41 21 20 27.00126
Desiree 0.52005815 55 27 28 16.15569
Unica 0.48083049 27 25 2 39.10400
```

```
# With ssi.method = "rao"
SSI(y = yield, sp = stab, gen = genotypes, method = "rao")
```

	SP	SSI	rSP	rY	means
102.18	0.26393535	1.5536988	14	23	26.31947
104.22	0.22971564	1.8193399	8	13	31.28887
121.31	0.32031744	1.5545939	19	15	30.10174
141.28	0.39838535	1.7570779	22	1	39.75624
157.26	0.53822924	1.5459114	28	5	36.95181
163.9	0.26659011	1.3869397	15	27	21.41747
221.19	0.19563325	1.6878048	3	26	22.98480
233.11	0.25167755	1.6641025	10	17	28.66655
235.6	0.46581370	1.6538090	24	4	38.63477
241.2	0.21481887	1.7134093	6	22	26.34039
255.7	0.30862904	1.5922105	17	14	30.58975
314.12	0.22603261	1.7307783	7	18	28.17335
317.6	0.20224771	2.0595024	5	9	35.32583
319.20	0.50675112	1.6259792	26	3	38.75767
320.16	0.23280596	1.6476346	9	21	26.34808
342.15	0.25989774	1.5545233	12	24	26.01336
346.2	0.37125512	1.2718506	20	25	23.84175
351.26	0.43805896	1.5966462	23	8	36.11581
364.21	0.07409309	3.5881882	2	10	34.05974
402.7	0.02004533	10.0539968	1	19	27.47748
405.2	0.26238837	1.6447637	13	16	28.98663
406.12	0.28179394	1.7171135	16	12	32.68323
427.7	0.20176581	2.0898536	4	7	36.19020
450.3	0.25465368	1.9010808	11	6	36.19602
506.2	0.30899851	1.6787677	18	11	33.26623
Canchan	0.37201039	1.3738642	21	20	27.00126
Desiree	0.52005815	0.8797586	27	28	16.15569
Unica	0.48083049	1.6568004	25	2	39.10400

```
# Changing the ratio of weights for Rao's SSI
SSI(y = yield, sp = stab, gen = genotypes, method = "rao", a = 0.43)
```

	SP	SSI	rSP	rY	means
102.18	0.26393535	1.1572429	14	23	26.31947
104.22	0.22971564	1.3638258	8	13	31.28887
121.31	0.32031744	1.2279220	19	15	30.10174
141.28	0.39838535	1.4944208	22	1	39.75624
157.26	0.53822924	1.3514985	28	5	36.95181
163.9	0.26659011	0.9944318	15	27	21.41747
221.19	0.19563325	1.1529329	3	26	22.98480
233.11	0.25167755	1.2483375	10	17	28.66655
235.6	0.46581370	1.4291726	24	4	38.63477
241.2	0.21481887	1.2263072	6	22	26.34039
255.7	0.30862904	1.2531668	17	14	30.58975
314.12	0.22603261	1.2678419	7	18	28.17335

```

317.6  0.20224771 1.5421234  5  9 35.32583
319.20 0.50675112 1.4194898 26  3 38.75767
320.16 0.23280596 1.1981670  9 21 26.34808
342.15 0.25989774 1.1519083 12 24 26.01336
346.2  0.37125512 0.9899993 20 25 23.84175
351.26 0.43805896 1.3577771 23  8 36.11581
364.21 0.07409309 2.1759278  2 10 34.05974
402.7  0.02004533 4.8338929  1 19 27.47748
405.2  0.26238837 1.2459704 13 16 28.98663
406.12 0.28179394 1.3457828 16 12 32.68323
427.7  0.20176581 1.5712389  4  7 36.19020
450.3  0.25465368 1.4901748 11  6 36.19602
506.2  0.30899851 1.3401295 18 11 33.26623
Canchan 0.37201039 1.0925852 21 20 27.00126
Desiree 0.52005815 0.6785528 27 28 16.15569
Unica  0.48083049 1.4391795 25  2 39.10400

```

Wrapper function

A function `ammistability` has also been implemented which is a wrapper around all the available functions in the package to compute simultaneously multiple AMMI stability parameters along with the corresponding SSIs. Correlation among the computed values as well as visualization of the differences in genotype ranks for the computed parameters is also generated.

Examples

```

library(agricolae)
data(plrv)

# AMMI model
model <- with(plrv, AMMI(Locality, Genotype, Rep, Yield, console = FALSE))

ammistability(model, AMGE = TRUE, ASI = FALSE, ASV = TRUE, ASTAB = FALSE,
              AVAMGE = FALSE, DA = FALSE, DZ = FALSE, EV = TRUE,
              FA = FALSE, MASI = FALSE, MASV = TRUE, SIPC = TRUE,
              ZA = FALSE)

```

```
ammistability()
```

```
$Details
```

```
$Details$`Stability parameters estimated`
```

```
[1] "AMGE" "ASV" "EV" "MASV" "SIPC"
```

```
$Details$`SSI method`
```

```
[1] "Farshadfar (2008)"
```

```
$`Stability Parameters`
```

	genotype	means	AMGE	ASV	EV	MASV	SIPC
1	102.18	26.31947	1.598721e-14	3.3801820	0.0232206231	4.7855876	2.9592568
2	104.22	31.28887	-8.881784e-15	1.4627695	0.0175897578	3.8328358	2.2591593
3	121.31	30.10174	1.643130e-14	2.2937918	0.0342010876	4.0446758	3.3872806
4	141.28	39.75624	-4.440892e-15	4.4672401	0.0529036285	5.1867706	4.3846248
5	157.26	36.95181	3.241851e-14	3.2923168	0.0965635719	7.6459224	5.4846596

6	163.9	21.41747	3.108624e-15	4.4269636	0.0236900961	4.4977055	2.6263670
7	221.19	22.98480	8.881784e-15	1.8014494	0.0127574566	2.1905344	2.0218098
8	233.11	28.66655	-1.476597e-14	1.0582263	0.0211138628	3.1794345	2.1624442
9	235.6	38.63477	-2.975398e-14	3.7647078	0.0723274691	8.4913020	4.8273551
10	241.2	26.34039	7.105427e-15	1.6774241	0.0153823821	2.0338659	2.0056410
11	255.7	30.58975	-1.598721e-14	3.3289736	0.0317506280	4.7013868	3.6075128
12	314.12	28.17335	-1.776357e-15	2.9170536	0.0170302467	3.1376678	2.4584089
13	317.6	35.32583	1.776357e-15	2.1874274	0.0136347120	2.3345492	1.8698826
14	319.20	38.75767	8.437695e-15	6.7164864	0.0855988994	8.6398087	5.9590451
15	320.16	26.34808	1.154632e-14	3.3208950	0.0180662044	3.8822326	2.7040109
16	342.15	26.01336	-9.325873e-15	2.9219360	0.0225156118	3.6438425	2.9755899
17	346.2	23.84175	-3.552714e-15	5.1827747	0.0459434537	5.3987165	3.9525017
18	351.26	36.11581	1.110223e-15	2.9786832	0.0639652186	5.4005468	4.5622439
19	364.21	34.05974	-4.940492e-15	0.7236998	0.0018299284	1.4047546	0.7526264
20	402.7	27.47748	-4.163336e-16	0.2801470	0.0001339385	0.3537818	0.2284995
21	405.2	28.98663	8.881784e-16	3.9832546	0.0229492190	4.1095727	2.7952381
22	406.12	32.68323	-1.731948e-14	2.5631734	0.0264692745	5.3218165	2.8834753
23	427.7	36.19020	-2.553513e-15	1.1467970	0.0135698145	2.4124676	2.0049278
24	450.3	36.19602	1.021405e-14	3.1430174	0.0216161656	4.6608954	2.8200387
25	506.2	33.26623	6.439294e-15	0.7511331	0.0318266934	1.9330143	2.2178470
26	Canchan	27.00126	-7.993606e-15	3.0975884	0.0461305761	3.6665608	3.5328212
27	Desiree	16.15569	1.754152e-14	7.7833445	0.0901534938	9.0626072	5.8073242
28	Unica	39.10400	-2.042810e-14	3.8380782	0.0770659860	8.5447632	5.0654615

\$`Simultaneous Selection Indices`

	genotype	means	AMGE_SSI	ASV_SSI	EV_SSI	MASV_SSI	SIPC_SSI
1	102.18	26.31947	48	43	37	42	39
2	104.22	31.28887	20	19	21	25	22
3	121.31	30.10174	41	25	34	29	33
4	141.28	39.75624	11	26	23	21	23
5	157.26	36.95181	33	22	33	29	31
6	163.9	21.41747	45	51	42	43	38
7	221.19	22.98480	48	34	29	31	32
8	233.11	28.66655	22	21	27	26	24
9	235.6	38.63477	5	25	28	29	28
10	241.2	26.34039	42	29	28	26	27
11	255.7	30.58975	18	33	31	32	34
12	314.12	28.17335	31	30	25	26	28
13	317.6	35.32583	26	18	14	15	12
14	319.20	38.75767	24	30	29	30	31
15	320.16	26.34808	45	39	30	34	33
16	342.15	26.01336	30	37	36	34	41
17	346.2	23.84175	36	51	45	47	46
18	351.26	36.11581	24	22	31	31	31
19	364.21	34.05974	19	12	12	12	12
20	402.7	27.47748	33	20	20	20	20
21	405.2	28.98663	31	39	29	31	29
22	406.12	32.68323	15	23	28	33	27
23	427.7	36.19020	19	12	11	14	11
24	450.3	36.19602	29	22	17	23	20
25	506.2	33.26623	30	14	29	14	19
26	Canchan	27.00126	28	35	41	31	39
27	Desiree	16.15569	55	56	55	56	55
28	Unica	39.10400	4	24	27	28	27

\$`SP Correlation`

	AMGE	ASV	EV	MASV	SIPC
AMGE	1.00**	<NA>	<NA>	<NA>	<NA>
ASV	0.16	1.00**	<NA>	<NA>	<NA>
EV	0.12	0.70**	1.00**	<NA>	<NA>
MASV	-0.01	0.81**	0.90**	1.00**	<NA>
SIPC	0.10	0.81**	0.96**	0.94**	1.00**

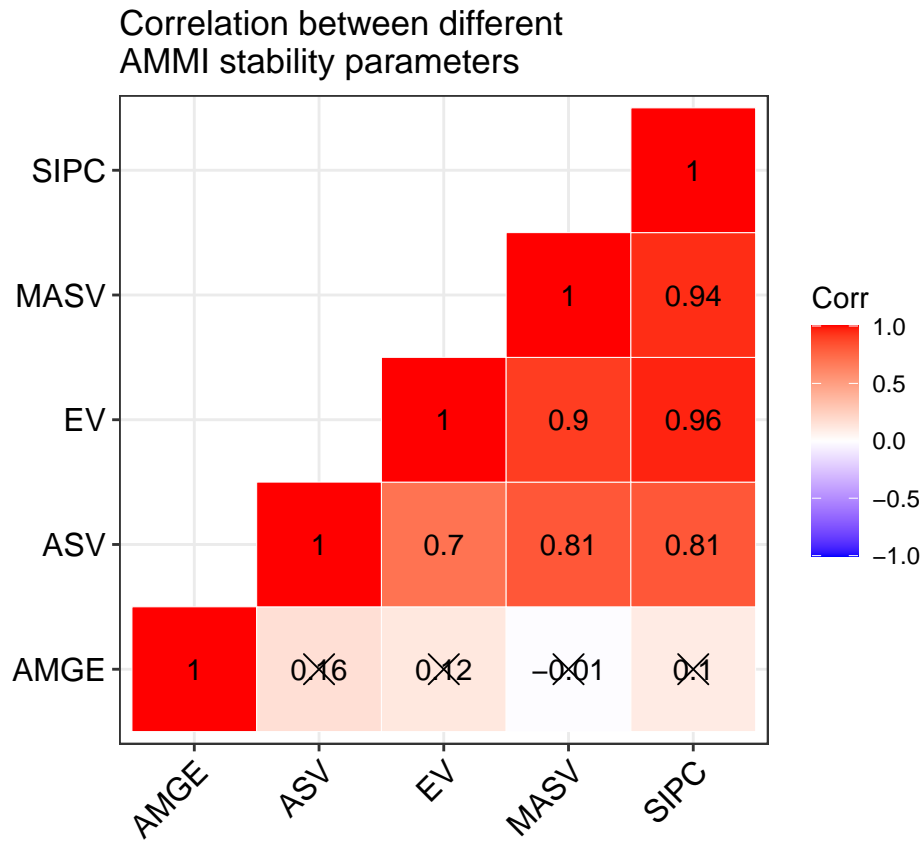
\$`SSI Correlation`

	AMGE	ASV	EV	MASV	SIPC
AMGE	1.00**	<NA>	<NA>	<NA>	<NA>
ASV	0.61**	1.00**	<NA>	<NA>	<NA>
EV	0.53**	0.84**	1.00**	<NA>	<NA>
MASV	0.52**	0.92**	0.90**	1.00**	<NA>
SIPC	0.53**	0.89**	0.96**	0.95**	1.00**

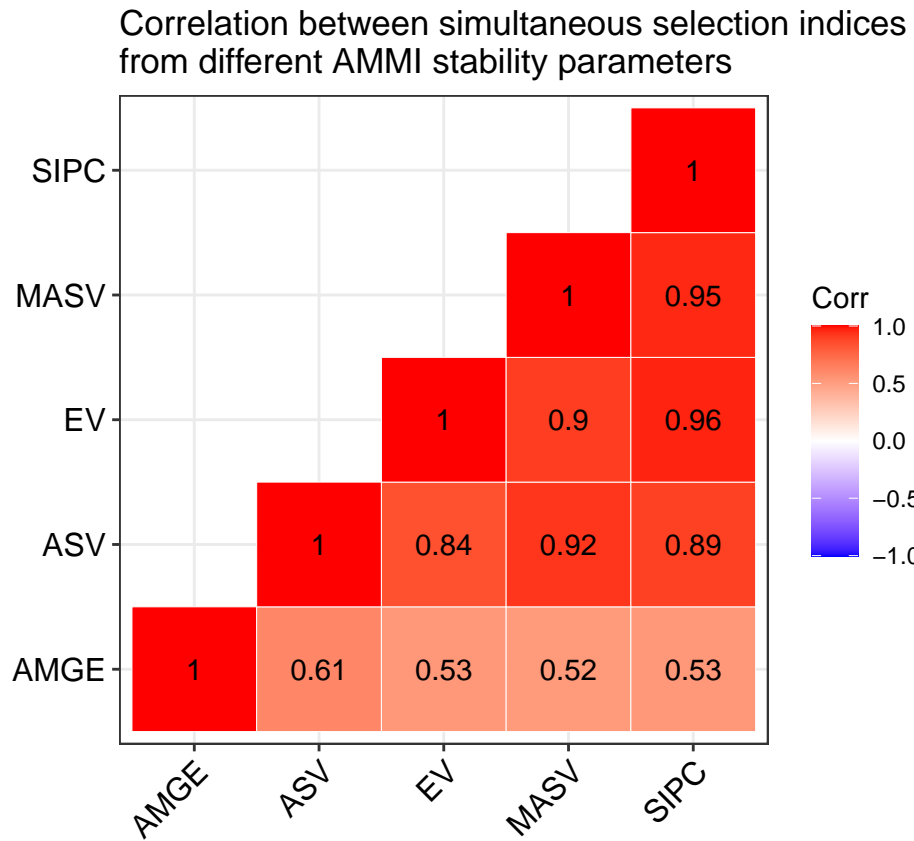
\$`SP and SSI Correlation`

	AMGE	ASV	EV	MASV	SIPC	AMGE_SSI	ASV_SSI	EV_SSI	MASV_SSI
AMGE	1.00**	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
ASV	0.16	1.00**	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
EV	0.12	0.70**	1.00**	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
MASV	-0.01	0.81**	0.90**	1.00**	<NA>	<NA>	<NA>	<NA>	<NA>
SIPC	0.10	0.81**	0.96**	0.94**	1.00**	<NA>	<NA>	<NA>	<NA>
AMGE_SSI	0.75**	0.17	-0.16	-0.18	-0.12	1.00**	<NA>	<NA>	<NA>
ASV_SSI	0.21	0.71**	0.21	0.35	0.34	0.61**	1.00**	<NA>	<NA>
EV_SSI	0.23	0.64**	0.48**	0.47*	0.53**	0.53**	0.84**	1.00**	<NA>
MASV_SSI	0.18	0.73**	0.40*	0.54**	0.51**	0.52**	0.92**	0.90**	1.00**
SIPC_SSI	0.20	0.70**	0.45*	0.50**	0.54**	0.53**	0.89**	0.96**	0.95**
SIPC_SSI									
AMGE	<NA>								
ASV	<NA>								
EV	<NA>								
MASV	<NA>								
SIPC	<NA>								
AMGE_SSI	<NA>								
ASV_SSI	<NA>								
EV_SSI	<NA>								
MASV_SSI	<NA>								
SIPC_SSI	1.00**								

\$`SP Correlogram`

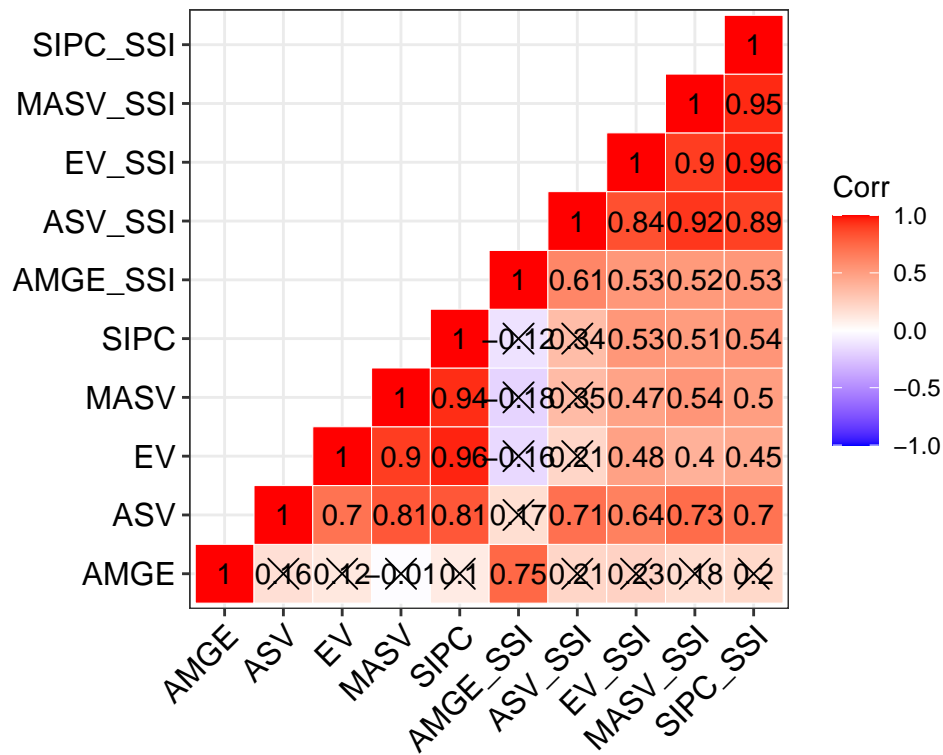


\$`SSI Correlogram`

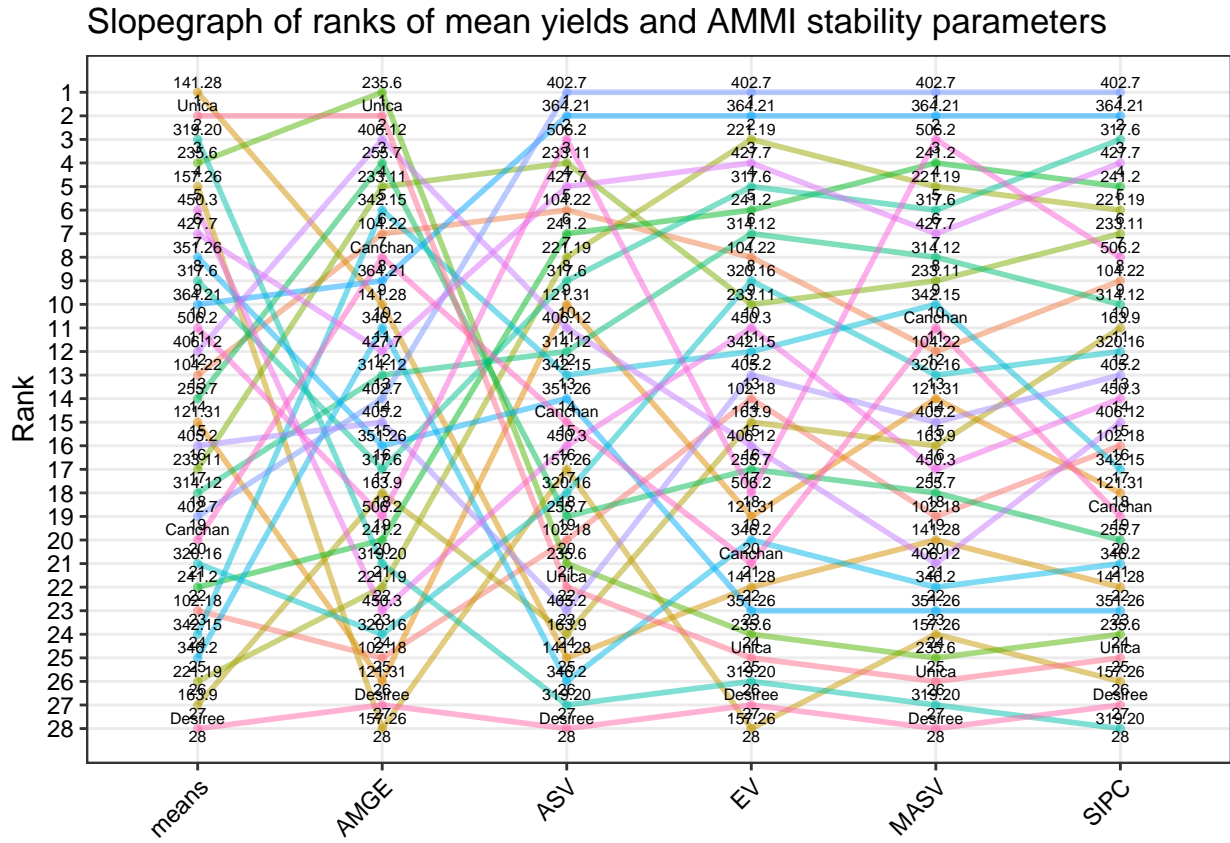


\$`SP and SSI Correlogram`

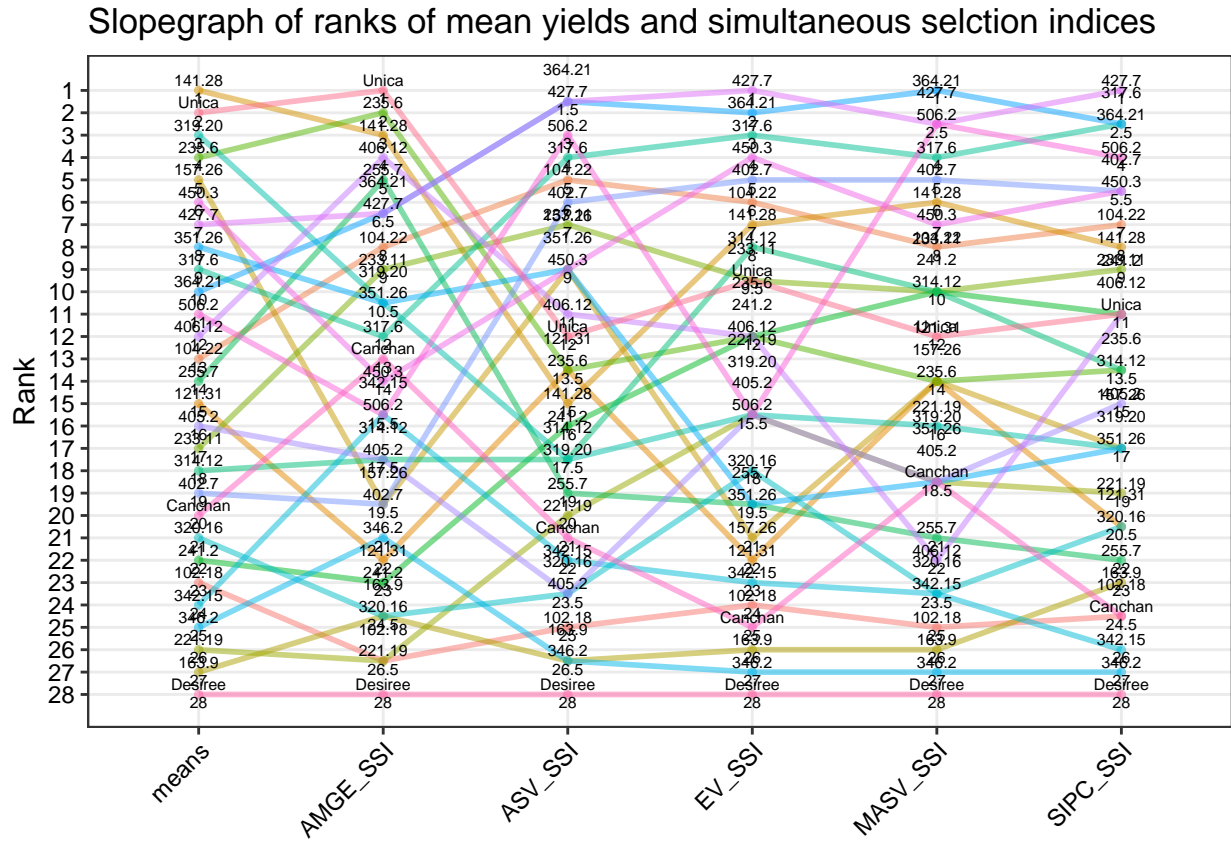
Correlation between different AMMI stability parameters and corresponding simultaneous selection indices



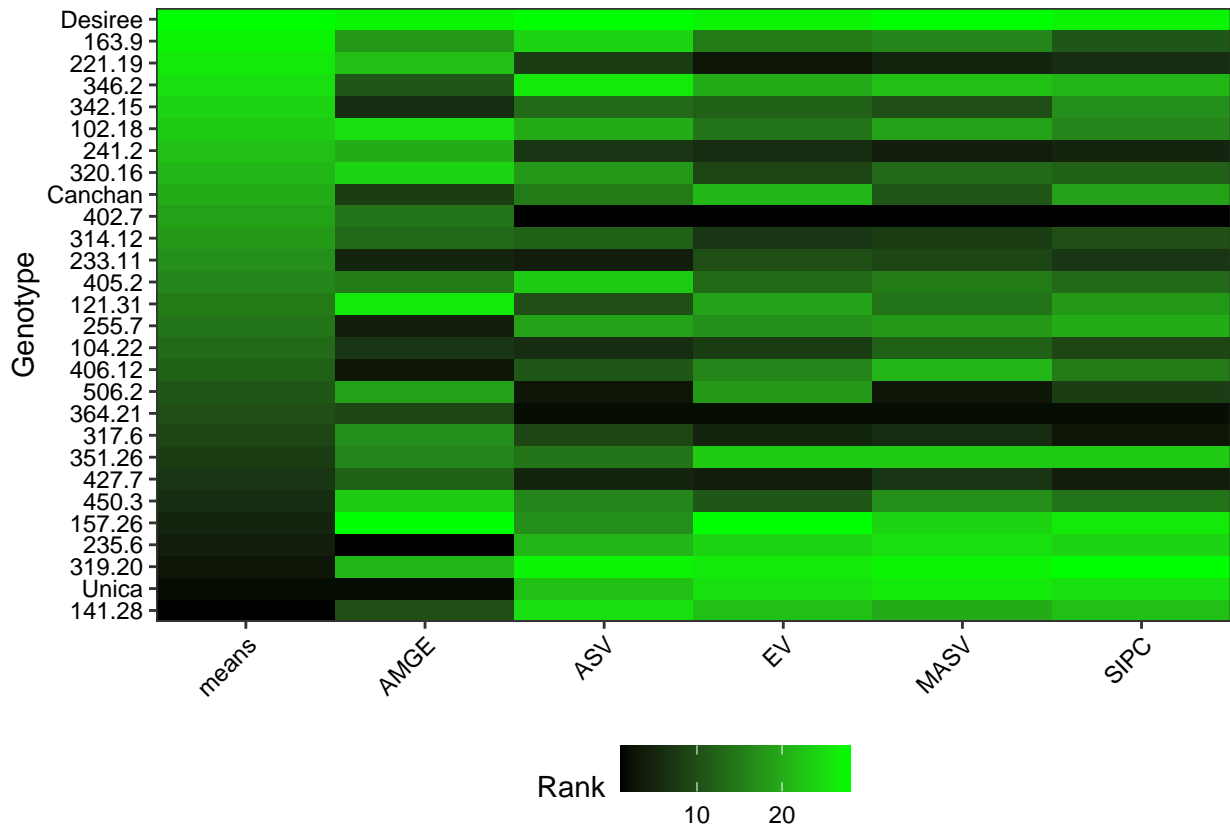
\$`SP Slopegraph`



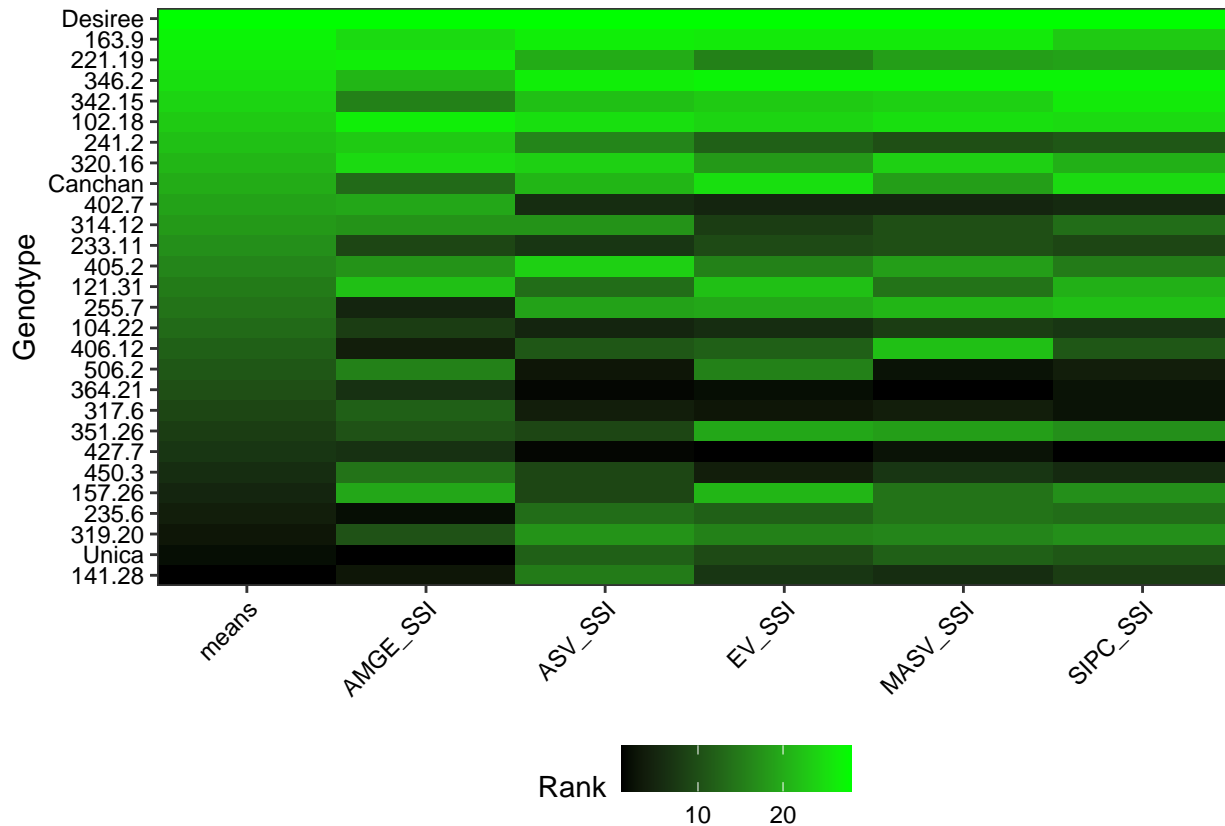
\$`SSI Slopegraph`



\$`SP Heatmap`



\$`SSI Heatmap`



Citing *ammistability*

To cite the R package '*ammistability*' in publications use:

Ajay, B. C., Aravind, J., and Abdul Fiyaz, R. (2019). *ammistability*: R package for ranking genotypes based on stability parameters derived from AMMI model. *Indian Journal of Genetics and Plant Breeding (The)*, 79(2), 460-466.

<https://www.isgpb.org/article/ammistability-r-package-for-ranking-genotypes-based-on-stability-parameters>

Ajay, B. C., Aravind, J., and Abdul Fiyaz, R. (). *ammistability*: Additive Main Effects and Multiplicative Interaction Model Stability Parameters. R package version 0.1.4,
<https://ajaygpb.github.io/ammistability/>,
<https://CRAN.R-project.org/package=ammistability>.

This free and open-source software implements academic research by the authors and co-workers. If you use it, please support the project by citing the package.

To see these entries in BibTeX format, use '`print(<citation>, bibtex=TRUE)`', '`toBibtex(.)`', or set '`options(citation.bibtex.max=999)`'.

Session Info

```
sessionInfo()
```

```
R Under development (unstable) (2023-04-29 r84347 ucrt)
Platform: x86_64-w64-mingw32/x64 (64-bit)
Running under: Windows 11 x64 (build 22621)
```

```
Matrix products: default
```

```
locale:
```

```
[1] LC_COLLATE=C                LC_CTYPE=English_India.utf8
[3] LC_MONETARY=English_India.utf8 LC_NUMERIC=C
[5] LC_TIME=English_India.utf8
```

```
time zone: Asia/Calcutta
```

```
tzcode source: internal
```

```
attached base packages:
```

```
[1] stats      graphics  grDevices  utils      datasets  methods    base
```

```
other attached packages:
```

```
[1] agricolae_1.3-5    ammistability_0.1.4
```

```
loaded via a namespace (and not attached):
```

```
[1] utf8_1.2.3          generics_0.1.3      bitops_1.0-7
[4] stringi_1.7.12     lattice_0.21-8     hms_1.1.3
[7] digest_0.6.31     magrittr_2.0.3     evaluate_0.20
[10] grid_4.4.0         fastmap_1.1.1      plyr_1.8.8
[13] combinat_0.0-8    promises_1.2.0.1   httr_1.4.5
[16] pander_0.6.5      fansi_1.0.4        scales_1.2.1
[19] XML_3.99-0.14     Rdpack_2.4         cli_3.6.1
[22] shiny_1.7.4       labelled_2.11.0    rlang_1.1.1
[25] rbibutils_2.2.13  ellipsis_0.3.2     munsell_0.5.0
[28] yaml_2.3.7        klaR_1.7-2         tools_4.4.0
[31] reshape2_1.4.4    AlgDesign_1.2.1    dplyr_1.1.2
[34] colorspace_2.1-0  ggplot2_3.3.5     mathjaxr_1.6-0
[37] httpuv_1.6.9      forcats_1.0.0     curl_5.0.0
[40] vctrs_0.6.2       R6_2.5.1          mime_0.12
[43] lifecycle_1.0.3   stringr_1.5.0     MASS_7.3-59
[46] miniUI_0.1.1.1    cluster_2.1.4     pkgconfig_2.0.3
[49] pillar_1.9.0      ggcorrplot_0.1.4  later_1.3.0
[52] gtable_0.3.3     glue_1.6.2        Rcpp_1.0.10
[55] haven_2.5.2       xfun_0.39         tibble_3.2.1
[58] tidyselect_1.2.0  highr_0.10        rstudioapi_0.14.0-9000
[61] knitr_1.42        farver_2.1.1      xtable_1.8-4
[64] nlme_3.1-162     htmltools_0.5.5   labeling_0.4.2
[67] rmarkdown_2.21   compiler_4.4.0    RCurl_1.98-1.12
[70] questionr_0.7.8
```

References

Ajay, B. C., Aravind, J., Abdul Fiyaz, R., Bera, S. K., Kumar, N., Gangadhar, K., et al. (2018). Modified AMMI Stability Index (MASI) for stability analysis. *ICAR-DGR Newsletter* 18, 4–5.

- Ajay, B. C., Aravind, J., and Fiyaz, R. A. (2019a). ammistability: R package for ranking genotypes based on stability parameters derived from AMMI model. *Indian Journal of Genetics and Plant Breeding (The)* 79, 460–466. doi:10.31742/IJGPB.79.2.10.
- Ajay, B. C., Aravind, J., Fiyaz, R. A., Kumar, N., Lal, C., Gangadhar, K., et al. (2019b). Rectification of modified AMMI stability value (MASV). *Indian Journal of Genetics and Plant Breeding (The)* 79, 726–731. Available at: <https://www.isgpb.org/article/rectification-of-modified-ammi-stability-value-masv>.
- Annicchiarico, P. (1997). Joint regression vs AMMI analysis of genotype-environment interactions for cereals in Italy. *Euphytica* 94, 53–62. doi:10.1023/A:1002954824178.
- Bajpai, P. K., and Prabhakaran, V. T. (2000). A new procedure of simultaneous selection for high yielding and stable crop genotypes. *Indian Journal of Genetics & Plant Breeding* 60, 141–146.
- Farshadfar, E. (2008). Incorporation of AMMI stability value and grain yield in a single non-parametric index (GSI) in bread wheat. *Pakistan Journal of biological sciences* 11, 1791. doi:10.3923/pjbs.2008.1791.1796.
- Farshadfar, E., Mahmodi, N., and Yaghotipoor, A. (2011). AMMI stability value and simultaneous estimation of yield and yield stability in bread wheat (*Triticum aestivum* L.). *Australian Journal of Crop Science* 5, 1837–1844.
- Gauch, H. G. (1988). Model selection and validation for yield trials with interaction. *Biometrics* 44, 705–715. doi:10.2307/2531585.
- Gauch, H. G. (1992). *Statistical Analysis of Regional Yield Trials: AMMI Analysis of Factorial Designs*. Amsterdam ; New York: Elsevier.
- Jambhulkar, N. N., Bose, L. K., Pande, K., and Singh, O. N. (2015). Genotype by environment interaction and stability analysis in rice genotypes. *Ecology, Environment and Conservation* 21, 1427–1430. Available at: http://www.envirobiotechjournals.com/article_abstract.php?aid=6346&iid=200&jid=3.
- Jambhulkar, N. N., Bose, L. K., and Singh, O. N. (2014). “AMMI stability index for stability analysis,” in *CRRI Newsletter, January-March 2014*, ed. T. Mohapatra (Cuttack, Orissa: Central Rice Research Institute), 15. Available at: https://crri.icar.gov.in/crnl_jan_mar_14_web.pdf.
- Jambhulkar, N. N., Rath, N. C., Bose, L. K., Subudhi, H., Biswajit, M., Lipi, D., et al. (2017). Stability analysis for grain yield in rice in demonstrations conducted during rabi season in India. *Oryza* 54, 236–240. doi:10.5958/2249-5266.2017.00030.3.
- Purchase, J. L. (1997). Parametric analysis to describe genotype \times environment interaction and yield stability in winter wheat. Available at: <https://scholar.ufs.ac.za:8080/xmlui/handle/11660/1966>.
- Purchase, J. L., Hatting, H., and Deventer, C. S. van (1999). “The use of the AMMI model and AMMI stability value to describe genotype \times environment interaction and yield stability in winter wheat (*Triticum aestivum* L.),” in *Proceedings of the Tenth Regional Wheat Workshop for Eastern, Central and Southern Africa, 14-18 September 1998* (South Africa: University of Stellenbosch).
- Purchase, J. L., Hatting, H., and Deventer, C. S. van (2000). Genotype \times environment interaction of winter wheat (*Triticum aestivum* L.) In South Africa: II. Stability analysis of yield performance. *South African Journal of Plant and Soil* 17, 101–107. doi:10.1080/02571862.2000.10634878.
- Raju, B. M. K. (2002). A study on AMMI model and its biplots. *Journal of the Indian Society of Agricultural Statistics* 55, 297–322.
- Rao, A. R., and Prabhakaran, V. T. (2005). Use of AMMI in simultaneous selection of genotypes for yield and stability. *Journal of the Indian Society of Agricultural Statistics* 59, 76–82.
- Sneller, C. H., Kilgore-Norquest, L., and Dombek, D. (1997). Repeatability of yield stability statistics in soybean. *Crop Science* 37, 383–390. doi:10.2135/cropsci1997.0011183X003700020013x.
- Wricke, G. (1962). On a method of understanding the biological diversity in field research. *Zeitschrift für Pflanzenzüchtung* 47, 92–146.
- Zali, H., Farshadfar, E., Sabaghpour, S. H., and Karimizadeh, R. (2012). Evaluation of genotype \times environment interaction in chickpea using measures of stability from AMMI model. *Annals of Biological Research* 3, 3126–3136.
- Zhang, Z., Lu, C., and Xiang, Z. (1998). Analysis of variety stability based on AMMI model. *Acta Agronomica Sinica* 24, 304–309. Available at: <https://zwxb.chinacrops.org/EN/Y1998/V24/I03/304>.
- Zobel, R. W. (1994). “Stress resistance and root systems,” in *Proceedings of the Workshop on Adaptation of Plants to Soil Stress. 1-4 August, 1993. INTSORMIL Publication 94-2* (Institute of Agriculture; Natural Resources, University of Nebraska-Lincoln), 80–99.