

The `ammistability` Package: A Brief Introduction

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

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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.

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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 0.1.1.9000
```

```
# 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 0.1.2. 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

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. $ASV = \sqrt{\left(\frac{SSIPC_1}{SSIPC_2} \times PC_1\right)^2 + (PC_2)^2}$	Purchase (1997) ; Purchase et al. (1999) ; Purchase et al. (2000)
$AV_{(AMGE)}$	<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 (D_a)	<code>DA.AMMI</code>	The unsquared Euclidean distance from the origin of significant IPC axes in the AMMI model. $D_a = \sqrt{\sum_{n=1}^{N'} (\lambda_n \gamma_{in})^2}$	Annicchiarico (1997)

AMMI stability parameter	function	Details	Reference
Zhang's D parameter or AMMI statistic coefficient or AMMI distance or AMMI stability index (D_z)	DZ.AMMI	The distance of IPC point from origin in space. $D_z = \sqrt{\sum_{n=1}^{N'} \gamma_{in}^2}$	Zhang et al. (1998)
Averages of the squared eigenvector values EV	EV.AMMI	$EV = \sum_{n=1}^{N'} \frac{\gamma_{in}^2}{N'}$	Zobel (1994)
Stability measure based on fitted AMMI model FA	FA.AMMI	$FA = \sum_{n=1}^{N'} \lambda_n^2 \gamma_{in}^2$	Raju (2002); Zali et al. (2012)
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)

AMMI stability parameter	function	Details	Reference
$W_{(AMMI)}$	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)
Sums of the absolute value of the IPC scores ($SIPC$)	SIPC.AMMI	$SIPC = \sum_{n=1}^{N'} \left \lambda_n^{0.5} \gamma_{in} \right $ $SIPC = \sum_{n=1}^{N'} PC_n $	Sneller et al. (1997)
Absolute value of the relative contribution of IPCs to the interaction (Za)	ZA.AMMI	$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$biplot
```

	type	Yield	PC1	PC2	PC3	PC4	PC5
102.18	GEN	26.31947	-1.50828851	1.258765244	-0.19220309	0.48738861	-0.04364115
104.22	GEN	31.28887	0.32517729	-1.297024517	-0.63695749	-0.44159957	0.95312506
121.31	GEN	30.10174	0.95604605	1.143461054	-1.28777348	2.22246913	-1.30661916
141.28	GEN	39.75624	2.11153737	0.817810467	1.45527701	0.25257620	-0.25996142
157.26	GEN	36.95181	1.05139017	2.461179974	-1.97208942	-1.96538800	-0.59719268
163.9	GEN	21.41747	-2.12407441	-0.284381234	-0.21791137	-0.50743629	0.18563390
221.19	GEN	22.98480	-0.84981828	0.347983673	-0.82400783	-0.11451944	-0.57504816
233.11	GEN	28.66655	0.07554203	-1.046497338	1.04040485	0.22868362	0.65754266
235.6	GEN	38.63477	1.20102029	-2.816581184	0.80975361	1.02013062	-0.40273415
241.2	GEN	26.34039	-0.79948495	0.220768053	-0.98538801	0.30004421	0.07555258
255.7	GEN	30.58975	-1.49543817	-1.186549449	0.92552519	-0.32009239	-0.46344763
314.12	GEN	28.17335	1.39335380	-0.332786322	-0.73226877	0.05987348	0.54406154
317.6	GEN	35.32583	1.05170769	0.002555823	-0.81561907	0.58180433	0.39627052
319.20	GEN	38.75767	3.08338144	1.995946966	0.87971668	-1.11908943	0.29657050
320.16	GEN	26.34808	-1.55737097	0.732314249	-0.41432567	1.32097009	2.29506737
342.15	GEN	26.01336	-1.35880873	-0.741980068	0.87480105	-1.12013125	-0.10776433

346.2	GEN	23.84175	-2.48453928	-0.397045286	1.07091711	-0.90974484	-0.12738693
351.26	GEN	36.11581	1.22670345	1.537183139	1.79835728	-0.03516368	0.30191335
364.21	GEN	34.05974	0.27328985	-0.447941156	0.03139543	0.77920500	-0.95811256
402.7	GEN	27.47748	-0.12907269	-0.080086669	0.01934016	-0.36085862	-0.28473777
405.2	GEN	28.98663	-1.90936369	0.309047963	0.57682642	0.51163370	-0.34397623
406.12	GEN	32.68323	0.90781100	-1.733433781	-0.24223050	-0.38596144	-0.49796296
427.7	GEN	36.19020	0.42791957	-0.723190970	-0.85381724	-0.53089914	1.00677993
450.3	GEN	36.19602	1.38026196	1.279525147	0.16025163	0.61270137	-0.34325251
506.2	GEN	33.26623	-0.33054261	-0.302588536	-1.58471588	-0.04659416	0.87807441
Canchan	GEN	27.00126	1.47802905	0.380553178	1.67423900	0.07718375	0.49381313
Desiree	GEN	16.15569	-3.64968796	1.720025405	0.43761089	0.04648011	-0.86767477
Unica	GEN	39.10400	1.25331924	-2.817033826	-0.99510845	-0.64366599	-0.90489253
Ayac	ENV	23.70254	-2.29611851	0.966037760	1.95959116	2.75548057	1.67177210
Hyo-02	ENV	45.73082	3.85283195	-5.093371615	1.16967118	-0.08985538	0.01540152
LM-02	ENV	34.64462	-1.14575146	-0.881093222	-4.56547274	0.55159099	0.52350416
LM-03	ENV	53.83493	5.34625518	4.265275487	-0.14143931	-0.11714533	-0.40285728
SR-02	ENV	14.95128	-2.58678337	0.660309540	0.89096920	-3.25055305	1.37283488
SR-03	ENV	11.15328	-3.17043379	0.082842050	0.68668051	0.15048221	-3.18065538

G*E matrix (deviations from mean)

```
array(model$genXenv, dim(model$genXenv), dimnames(model$genXenv))
```

	ENV					
GEN	Ayac	Hyo-02	LM-02	LM-03	SR-02	SR-03
102.18	5.5726162	-12.4918224	1.7425251	-2.7070438	2.91734869	4.9663762
104.22	-2.8712076	7.1684102	3.9336218	-4.0358373	0.47881580	-4.6738028
121.31	0.3255230	-3.8666836	4.3182811	10.4366135	-11.88343843	0.6697043
141.28	-0.9451837	5.6454825	-9.7806639	14.6463104	-4.80337115	-4.7625741
157.26	-10.3149711	-10.6241677	4.2336365	16.8683612	2.71710210	-2.8799609
163.9	3.0874931	-6.9416721	3.4963790	-12.5533271	7.01688164	5.8942454
221.19	-0.6041752	-6.0090018	4.0648518	-2.6974743	1.27671246	3.9690870
233.11	2.5837535	6.8277609	-3.4440645	-4.4985717	0.19989490	-1.6687730
235.6	-1.7541523	19.8225025	-2.2394463	-5.6643239	-8.11400542	-2.0505746
241.2	1.0710975	-5.3831118	5.4253097	-3.2588271	0.46433086	1.6812008
255.7	2.4443155	1.3860497	-1.8857757	-12.9626594	4.31373929	6.7043306
314.12	-3.8812099	6.2098482	2.3577759	5.9071782	-3.92419060	-6.6694018
317.6	-1.7450319	3.0388540	3.0448064	5.5211634	-4.79271565	-5.0670763
319.20	-6.0155949	2.8477540	-9.7697504	24.8850017	-1.82949467	-10.1179157
320.16	10.9481796	-10.2982108	4.9608280	-6.2233088	2.99984918	-2.3873373
342.15	0.8508002	-0.3338618	-2.4575390	-10.3783871	7.29753151	5.0214562
346.2	4.7000495	-6.2178087	-2.2612391	-14.9700672	9.90123888	8.8478267
351.26	2.6002030	-0.9918665	-10.8315931	12.7429121	-0.02713985	-3.4925156
364.21	-0.4533734	3.2864208	-0.1335527	-0.1592533	-4.82292664	2.2826853
402.7	-1.2134573	-0.0387229	-0.2179557	-0.8774011	1.08032472	1.2672123
405.2	6.6477681	-8.3071271	-0.6159895	-8.8927189	3.52179705	7.6462704
406.12	-6.1296667	12.0703469	1.1195092	-2.2601009	-3.13776595	-1.6623226
427.7	-3.1340922	4.3967072	4.2792028	-1.0194744	0.76266844	-5.2850119
450.3	-0.5047010	-1.0720791	-3.2821761	12.8806007	-5.04562407	-2.9760204
506.2	-1.2991912	-1.5682154	8.3142802	-3.1819279	0.60021498	-2.8651608
Canchan	1.2929442	5.7152780	-9.3713622	9.0803035	-1.65332869	-5.0638348
Desiree	9.5767845	-22.3280421	0.2396387	-11.8935722	9.62433886	14.7808522
Unica	-10.8355195	18.0569790	4.7604622	-4.7341684	-5.13878822	-2.1089651


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

```
AMGE.AMMI()
```

	AMGE	SSI	rAMGE	rY	means
102.18	-8.659740e-15	28.0	5.0	23	26.31947
104.22	1.110223e-15	28.0	15.0	13	31.28887
121.31	4.440892e-16	29.0	14.0	15	30.10174
141.28	1.021405e-14	27.5	26.5	1	39.75624
157.26	2.220446e-15	22.5	17.5	5	36.95181
163.9	-1.243450e-14	28.0	1.0	27	21.41747
221.19	-4.440892e-15	35.0	9.0	26	22.98480
233.11	2.275957e-15	36.0	19.0	17	28.66655
235.6	5.773160e-15	26.5	22.5	4	38.63477
241.2	-5.329071e-15	30.0	8.0	22	26.34039
255.7	-3.774758e-15	24.0	10.0	14	30.58975
314.12	5.773160e-15	40.5	22.5	18	28.17335
317.6	2.220446e-15	26.5	17.5	9	35.32583
319.20	1.731948e-14	31.0	28.0	3	38.75767
320.16	-6.217249e-15	27.0	6.0	21	26.34808
342.15	-2.442491e-15	35.0	11.0	24	26.01336
346.2	-1.110223e-14	28.0	3.0	25	23.84175
351.26	1.021405e-14	34.5	26.5	8	36.11581
364.21	1.415534e-15	26.0	16.0	10	34.05974
402.7	-3.885781e-16	31.0	12.0	19	27.47748
405.2	-1.088019e-14	20.0	4.0	16	28.98663
406.12	3.108624e-15	32.0	20.0	12	32.68323
427.7	1.110223e-16	20.0	13.0	7	36.19020
450.3	6.439294e-15	30.0	24.0	6	36.19602
506.2	-5.773160e-15	18.0	7.0	11	33.26623
Canchan	9.325873e-15	45.0	25.0	20	27.00126
Desiree	-1.132427e-14	30.0	2.0	28	16.15569
Unica	5.329071e-15	23.0	21.0	2	39.10400

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

	AMGE	SSI	rAMGE	rY	means
102.18	-9.992007e-15	28	5	23	26.31947
104.22	2.886580e-15	31	18	13	31.28887
121.31	-3.996803e-15	25	10	15	30.10174
141.28	9.992007e-15	27	26	1	39.75624
157.26	8.881784e-15	29	24	5	36.95181
163.9	-1.065814e-14	29	2	27	21.41747
221.19	-4.718448e-15	35	9	26	22.98480
233.11	1.387779e-15	32	15	17	28.66655
235.6	3.108624e-15	23	19	4	38.63477
241.2	-6.550316e-15	29	7	22	26.34039
255.7	-3.774758e-15	25	11	14	30.58975
314.12	6.217249e-15	41	23	18	28.17335
317.6	0.000000e+00	22	13	9	35.32583
319.20	2.087219e-14	31	28	3	38.75767
320.16	-1.021405e-14	25	4	21	26.34808

```

342.15  2.053913e-15  41    17 24 26.01336
346.2   -7.993606e-15  31     6 25 23.84175
351.26  9.159340e-15  33    25 8 36.11581
364.21  -8.881784e-16  22    12 10 34.05974
402.7   2.983724e-16  33    14 19 27.47748
405.2   -1.326717e-14  17     1 16 28.98663
406.12  3.552714e-15  32    20 12 32.68323
427.7   1.887379e-15  23    16 7 36.19020
450.3   5.107026e-15  27    21 6 36.19602
506.2   -5.592748e-15  19     8 11 33.26623
Canchan 1.010303e-14  47    27 20 27.00126
Desiree -1.043610e-14  31     3 28 16.15569
Unica   5.773160e-15  24    22 2 39.10400

```

```

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

```

	AMGE	SSI	rAMGE	rY	means
102.18	-8.659740e-15	0.5673198	5.0	23	26.31947
104.22	1.110223e-15	3.2887624	15.0	13	31.28887
121.31	4.440892e-16	6.6529106	14.0	15	30.10174
141.28	1.021405e-14	1.5428597	26.5	1	39.75624
157.26	2.220446e-15	2.3391212	17.5	5	36.95181
163.9	-1.243450e-14	0.4957785	1.0	27	21.41747
221.19	-4.440892e-15	0.1822906	9.0	26	22.98480
233.11	2.275957e-15	2.0413097	19.0	17	28.66655
235.6	5.773160e-15	1.6959735	22.5	4	38.63477
241.2	-5.329071e-15	0.3862254	8.0	22	26.34039
255.7	-3.774758e-15	0.3301705	10.0	14	30.58975
314.12	5.773160e-15	1.3548726	22.5	18	28.17335
317.6	2.220446e-15	2.2861050	17.5	9	35.32583
319.20	1.731948e-14	1.4091383	28.0	3	38.75767
320.16	-6.217249e-15	0.4539931	6.0	21	26.34808
342.15	-2.442491e-15	-0.1829870	11.0	24	26.01336
346.2	-1.110223e-14	0.5505176	3.0	25	23.84175
351.26	1.021405e-14	1.4241614	26.5	8	36.11581
364.21	1.415534e-15	2.8898091	16.0	10	34.05974
402.7	-3.885781e-16	-5.5857093	12.0	19	27.47748
405.2	-1.088019e-14	0.7136396	4.0	16	28.98663
406.12	3.108624e-15	1.8758598	20.0	12	32.68323
427.7	1.110223e-16	23.8657048	13.0	7	36.19020
450.3	6.439294e-15	1.5713258	24.0	6	36.19602
506.2	-5.773160e-15	0.6484020	7.0	11	33.26623
Canchan	9.325873e-15	1.1504601	25.0	20	27.00126
Desiree	-1.132427e-14	0.3043571	2.0	28	16.15569
Unica	5.329071e-15	1.7476282	21.0	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	-8.659740e-15	0.7330999	5.0	23	26.31947
104.22	1.110223e-15	1.9956774	15.0	13	31.28887
121.31	4.440892e-16	3.4201982	14.0	15	30.10174
141.28	1.021405e-14	1.4023070	26.5	1	39.75624
157.26	2.220446e-15	1.6925787	17.5	5	36.95181

```

163.9   -1.243450e-14  0.6112325   1.0 27 21.41747
221.19 -4.440892e-15  0.5055618   9.0 26 22.98480
233.11  2.275957e-15  1.4105366  19.0 17 28.66655
235.6   5.773160e-15  1.4473033  22.5  4 38.63477
241.2   -5.329071e-15  0.6556181   8.0 22 26.34039
255.7   -3.774758e-15  0.7104896  10.0 14 30.58975
314.12  5.773160e-15  1.1062024  22.5 18 28.17335
317.6   2.220446e-15  1.6395625  17.5  9 35.32583
319.20  1.731948e-14  1.3262482  28.0  3 38.75767
320.16 -6.217249e-15  0.6849012   6.0 21 26.34808
342.15 -2.442491e-15  0.4047789  11.0 24 26.01336
346.2   -1.110223e-14  0.6798261   3.0 25 23.84175
351.26  1.021405e-14  1.2836086  26.5  8 36.11581
364.21  1.415534e-15  1.8756248  16.0 10 34.05974
402.7   -3.885781e-16 -1.8911807  12.0 19 27.47748
405.2   -1.088019e-14  0.8455870   4.0 16 28.98663
406.12  3.108624e-15  1.4140438  20.0 12 32.68323
427.7   1.110223e-16 10.9348548  13.0  7 36.19020
450.3   6.439294e-15  1.3483801  24.0  6 36.19602
506.2   -5.773160e-15  0.8970722   7.0 11 33.26623
Canchan 9.325873e-15  0.9965214  25.0 20 27.00126
Desiree -1.132427e-14  0.4311301   2.0 28 16.15569
Unica   5.329071e-15  1.4782355  21.0  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 -8.659740e-15 3.3801820 0.0232206231 4.7855876 2.9592568
2    104.22 31.28887 1.110223e-15 1.4627695 0.0175897578 3.8328358 2.2591593
3    121.31 30.10174 4.440892e-16 2.2937918 0.0342010876 4.0446758 3.3872806
4    141.28 39.75624 1.021405e-14 4.4672401 0.0529036285 5.1867706 4.3846248
5    157.26 36.95181 2.220446e-15 3.2923168 0.0965635719 7.6459224 5.4846596
6    163.9 21.41747 -1.243450e-14 4.4269636 0.0236900961 4.4977055 2.6263670
7    221.19 22.98480 -4.440892e-15 1.8014494 0.0127574566 2.1905344 2.0218098
8    233.11 28.66655 2.275957e-15 1.0582263 0.0211138628 3.1794345 2.1624442
9    235.6 38.63477 5.773160e-15 3.7647078 0.0723274691 8.4913020 4.8273551
```

```

10  241.2 26.34039 -5.329071e-15 1.6774241 0.0153823821 2.0338659 2.0056410
11  255.7 30.58975 -3.774758e-15 3.3289736 0.0317506280 4.7013868 3.6075128
12  314.12 28.17335 5.773160e-15 2.9170536 0.0170302467 3.1376678 2.4584089
13  317.6 35.32583 2.220446e-15 2.1874274 0.0136347120 2.3345492 1.8698826
14  319.20 38.75767 1.731948e-14 6.7164864 0.0855988994 8.6398087 5.9590451
15  320.16 26.34808 -6.217249e-15 3.3208950 0.0180662044 3.8822326 2.7040109
16  342.15 26.01336 -2.442491e-15 2.9219360 0.0225156118 3.6438425 2.9755899
17  346.2 23.84175 -1.110223e-14 5.1827747 0.0459434537 5.3987165 3.9525017
18  351.26 36.11581 1.021405e-14 2.9786832 0.0639652186 5.4005468 4.5622439
19  364.21 34.05974 1.415534e-15 0.7236998 0.0018299284 1.4047546 0.7526264
20  402.7 27.47748 -3.885781e-16 0.2801470 0.0001339385 0.3537818 0.2284995
21  405.2 28.98663 -1.088019e-14 3.9832546 0.0229492190 4.1095727 2.7952381
22  406.12 32.68323 3.108624e-15 2.5631734 0.0264692745 5.3218165 2.8834753
23  427.7 36.19020 1.110223e-16 1.1467970 0.0135698145 2.4124676 2.0049278
24  450.3 36.19602 6.439294e-15 3.1430174 0.0216161656 4.6608954 2.8200387
25  506.2 33.26623 -5.773160e-15 0.7511331 0.0318266934 1.9330143 2.2178470
26  Canchan 27.00126 9.325873e-15 3.0975884 0.0461305761 3.6665608 3.5328212
27  Desiree 16.15569 -1.132427e-14 7.7833445 0.0901534938 9.0626072 5.8073242
28  Unica 39.10400 5.329071e-15 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	28.0	43	37	42	39
2	104.22	31.28887	28.0	19	21	25	22
3	121.31	30.10174	29.0	25	34	29	33
4	141.28	39.75624	27.5	26	23	21	23
5	157.26	36.95181	22.5	22	33	29	31
6	163.9	21.41747	28.0	51	42	43	38
7	221.19	22.98480	35.0	34	29	31	32
8	233.11	28.66655	36.0	21	27	26	24
9	235.6	38.63477	26.5	25	28	29	28
10	241.2	26.34039	30.0	29	28	26	27
11	255.7	30.58975	24.0	33	31	32	34
12	314.12	28.17335	40.5	30	25	26	28
13	317.6	35.32583	26.5	18	14	15	12
14	319.20	38.75767	31.0	30	29	30	31
15	320.16	26.34808	27.0	39	30	34	33
16	342.15	26.01336	35.0	37	36	34	41
17	346.2	23.84175	28.0	51	45	47	46
18	351.26	36.11581	34.5	22	31	31	31
19	364.21	34.05974	26.0	12	12	12	12
20	402.7	27.47748	31.0	20	20	20	20
21	405.2	28.98663	20.0	39	29	31	29
22	406.12	32.68323	32.0	23	28	33	27
23	427.7	36.19020	20.0	12	11	14	11
24	450.3	36.19602	30.0	22	17	23	20
25	506.2	33.26623	18.0	14	29	14	19
26	Canchan	27.00126	45.0	35	41	31	39
27	Desiree	16.15569	30.0	56	55	56	55
28	Unica	39.10400	23.0	24	27	28	27

\$`SP Correlation`

	AMGE	ASV	EV	MASV	SIPC
AMGE	1.00**	<NA>	<NA>	<NA>	<NA>

```

ASV    -0.03 1.00**    <NA>    <NA>    <NA>
EV      0.31 0.70**  1.00**    <NA>    <NA>
MASV    0.21 0.81**  0.90**  1.00**    <NA>
SIPC    0.28 0.81**  0.96**  0.94**  1.00**

```

```
$`SSI Correlation`
```

```

      AMGE    ASV    EV    MASV    SIPC
AMGE 1.00**    <NA>    <NA>    <NA>    <NA>
ASV   0.20 1.00**    <NA>    <NA>    <NA>
EV    0.24 0.84**  1.00**    <NA>    <NA>
MASV  0.23 0.92**  0.90**  1.00**    <NA>
SIPC  0.32 0.89**  0.96**  0.95**  1.00**

```

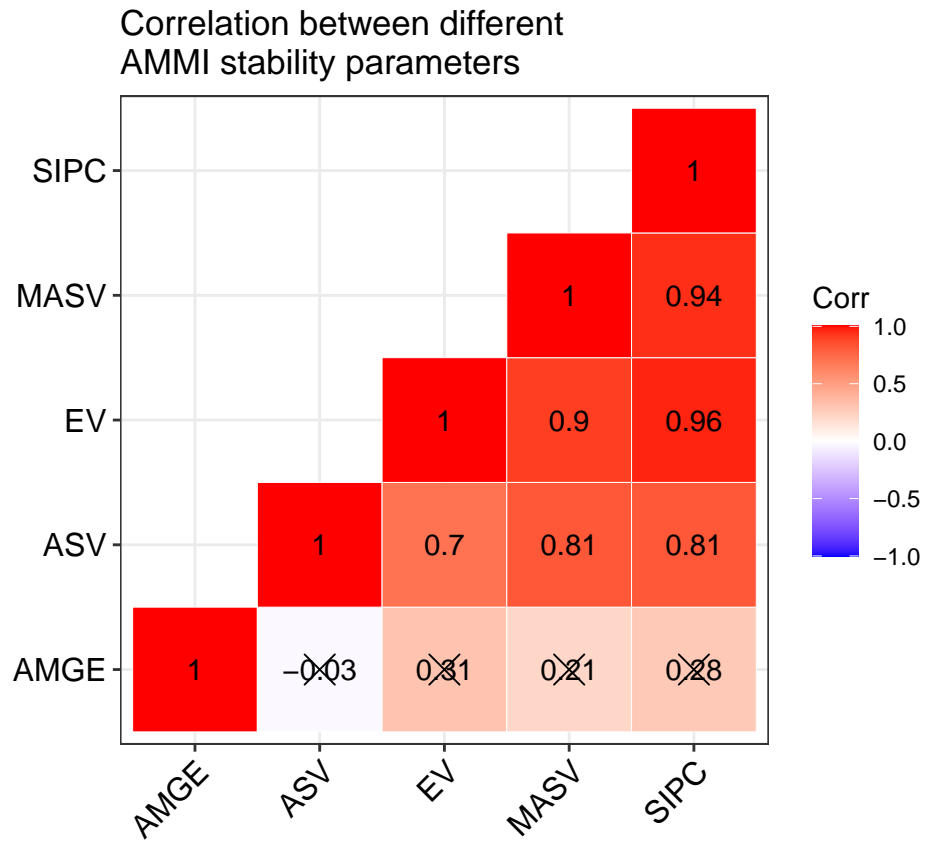
```
$`SP and SSI Correlation`
```

```

      AMGE    ASV    EV    MASV    SIPC  AMGE_SSI  ASV_SSI  EV_SSI  MASV_SSI  SIPC_SSI
AMGE   1.00**    <NA>    <NA>    <NA>    <NA>    <NA>    <NA>    <NA>    <NA>    <NA>
ASV    -0.03 1.00**    <NA>    <NA>    <NA>    <NA>    <NA>    <NA>    <NA>    <NA>
EV      0.31 0.70**  1.00**    <NA>    <NA>    <NA>    <NA>    <NA>    <NA>    <NA>
MASV    0.21 0.81**  0.90**  1.00**    <NA>    <NA>    <NA>    <NA>    <NA>    <NA>
SIPC    0.28 0.81**  0.96**  0.94**  1.00**    <NA>    <NA>    <NA>    <NA>    <NA>
AMGE_SSI 0.34  0.03 -0.08 -0.10 -0.03  1.00**    <NA>    <NA>    <NA>    <NA>
ASV_SSI -0.56** 0.71**  0.21  0.35  0.34  0.20  1.00**    <NA>    <NA>    <NA>
EV_SSI  -0.42* 0.64**  0.48**  0.47* 0.53** 0.24  0.84**  1.00**    <NA>    <NA>
MASV_SSI -0.46* 0.73**  0.40*  0.54** 0.51** 0.23  0.92**  0.90**  1.00**    <NA>
SIPC_SSI -0.38* 0.70**  0.45*  0.50** 0.54** 0.32  0.89**  0.96**  0.95**  1.00**

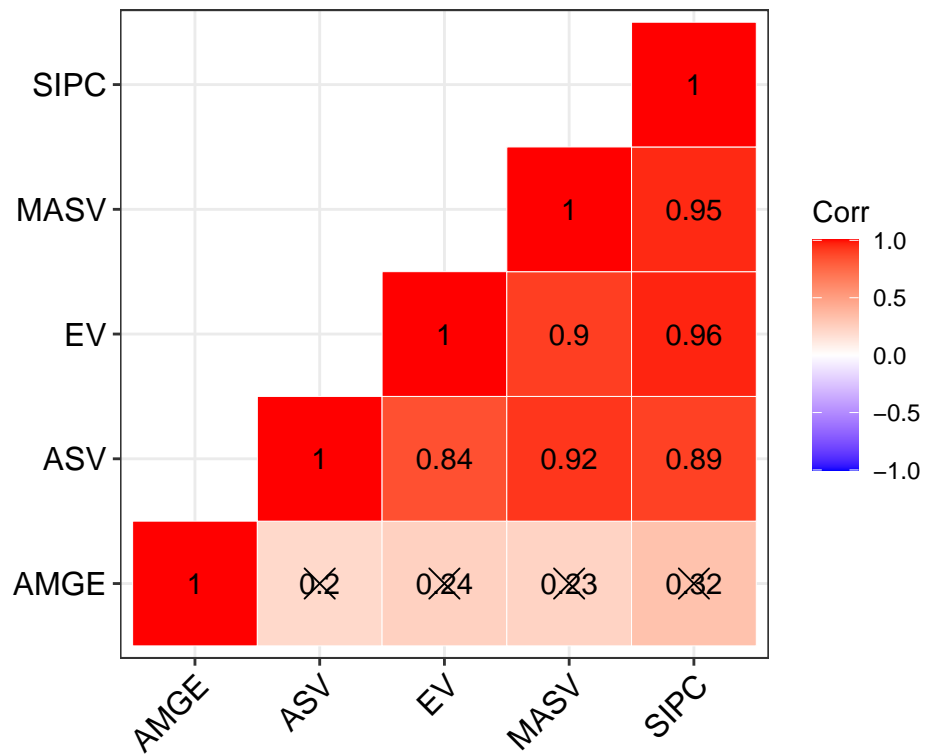
```

```
$`SP Correlogram`
```

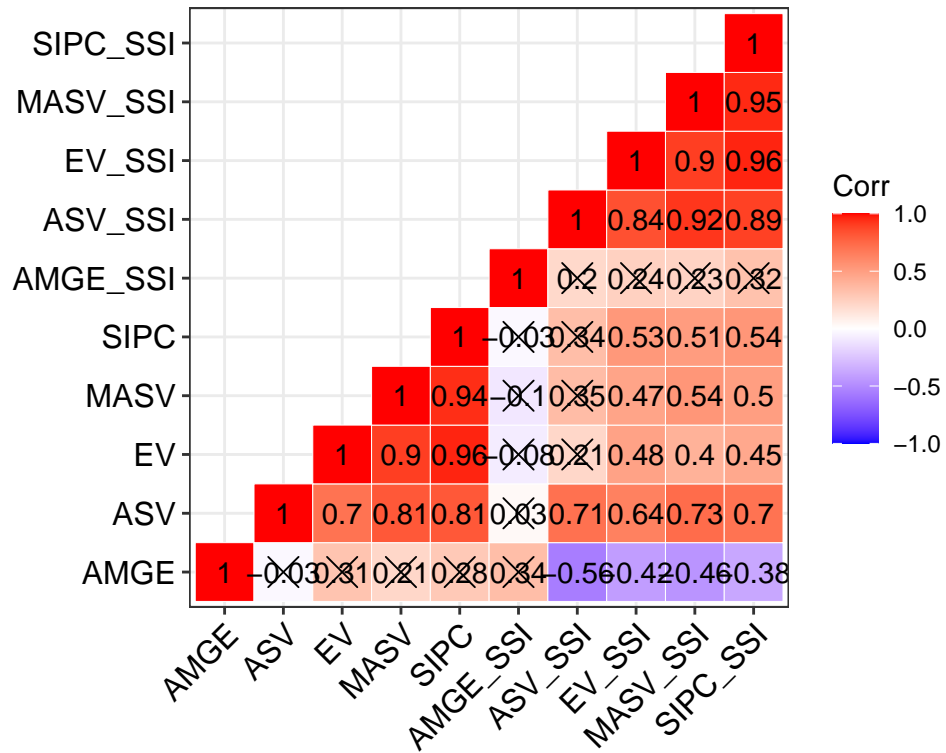
\$`SSI Correlogram`

Correlation between simultaneous selection indices
from different AMMI stability parameters

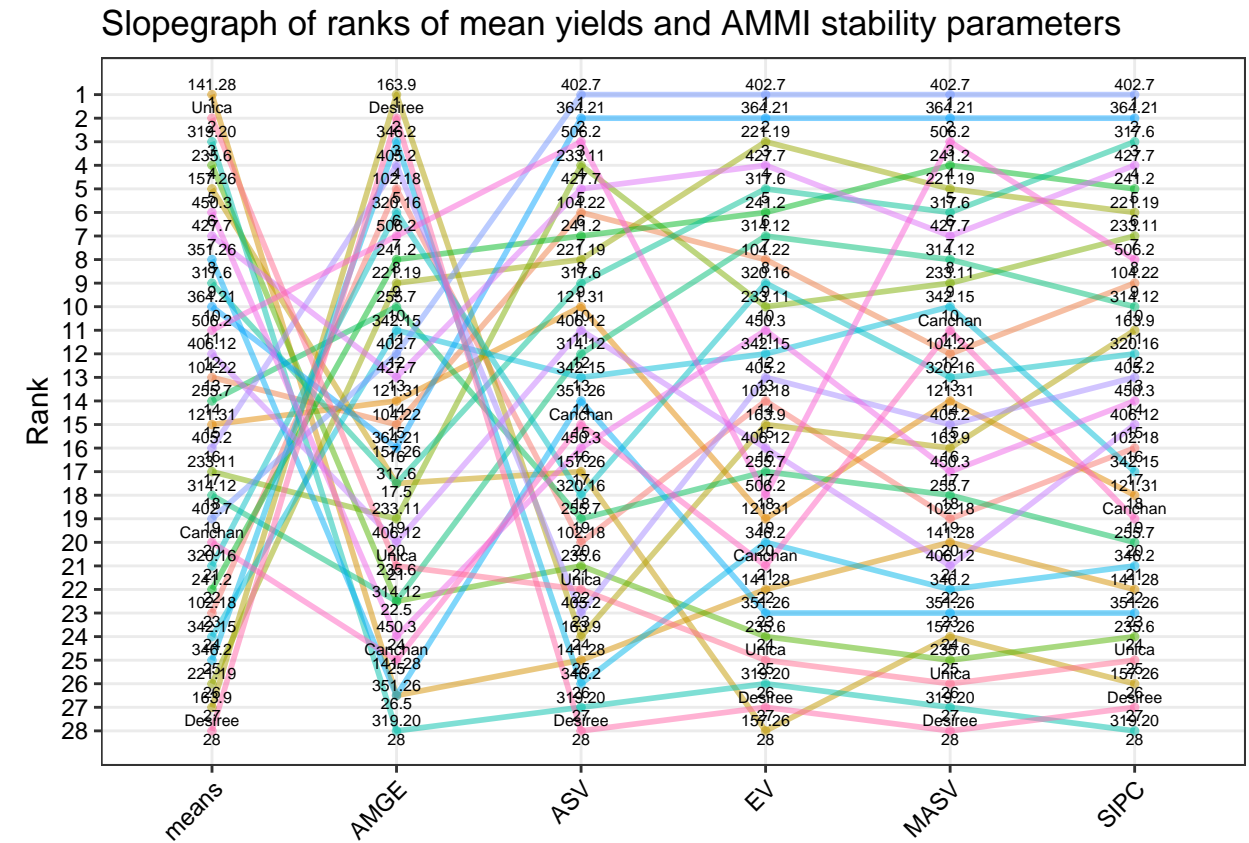


\$`SP and SSI Correlogram`

Correlation between different AMMI stability parameters and corresponding simultaneous selection indices

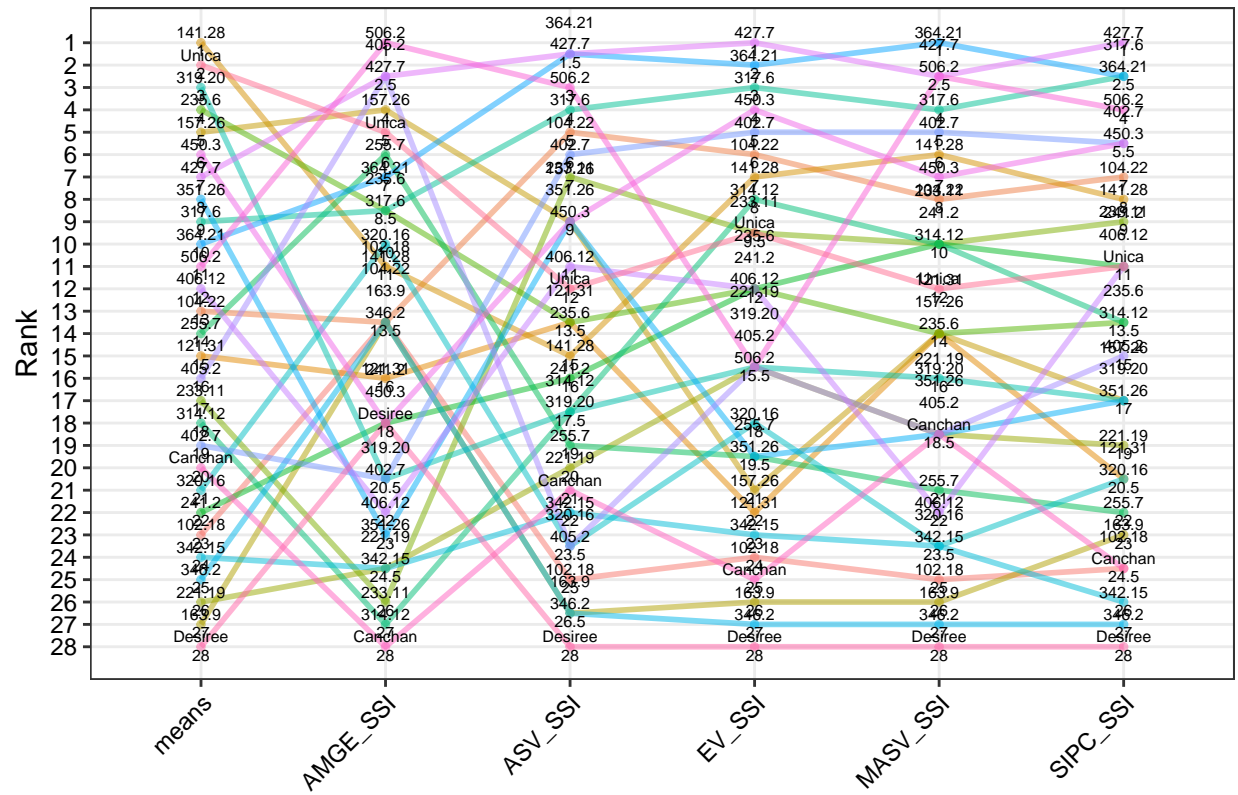


\$`SP Slopegraph`

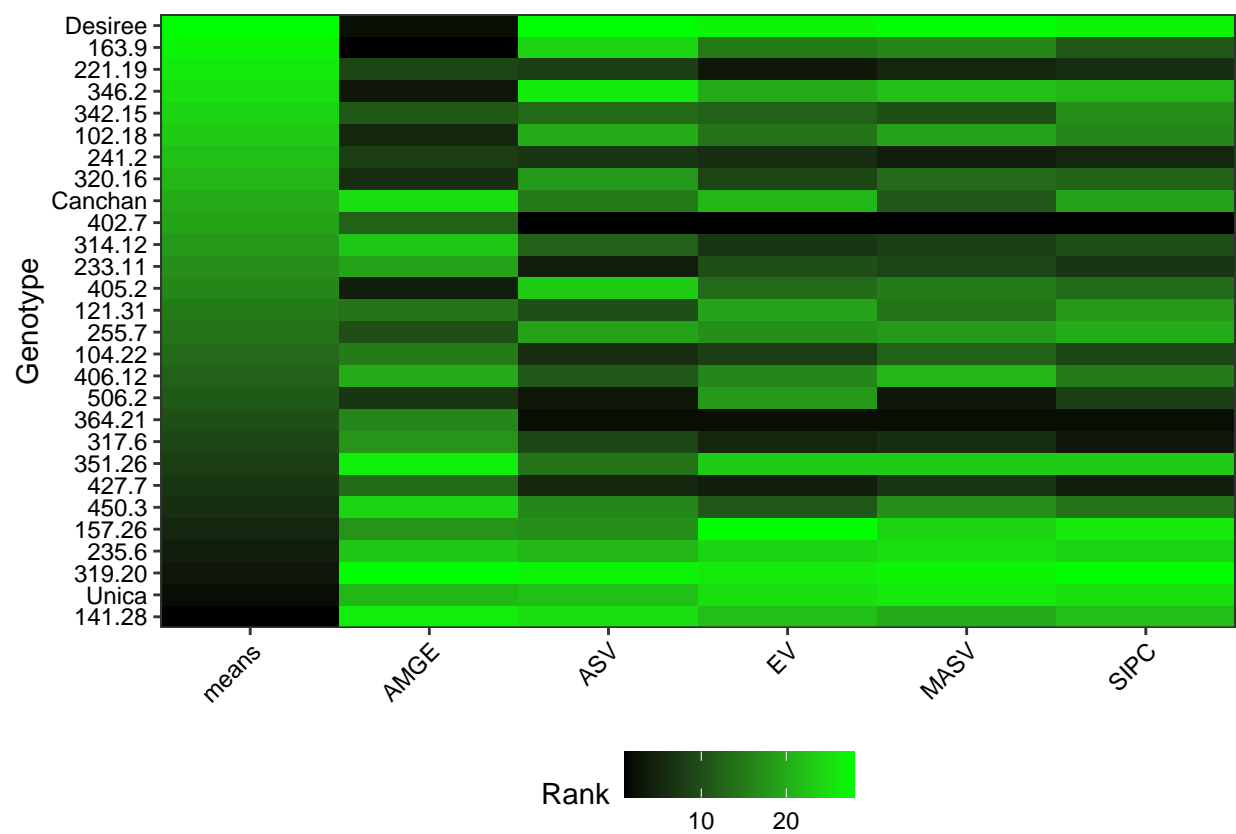


\$`SSI Slopegraph`

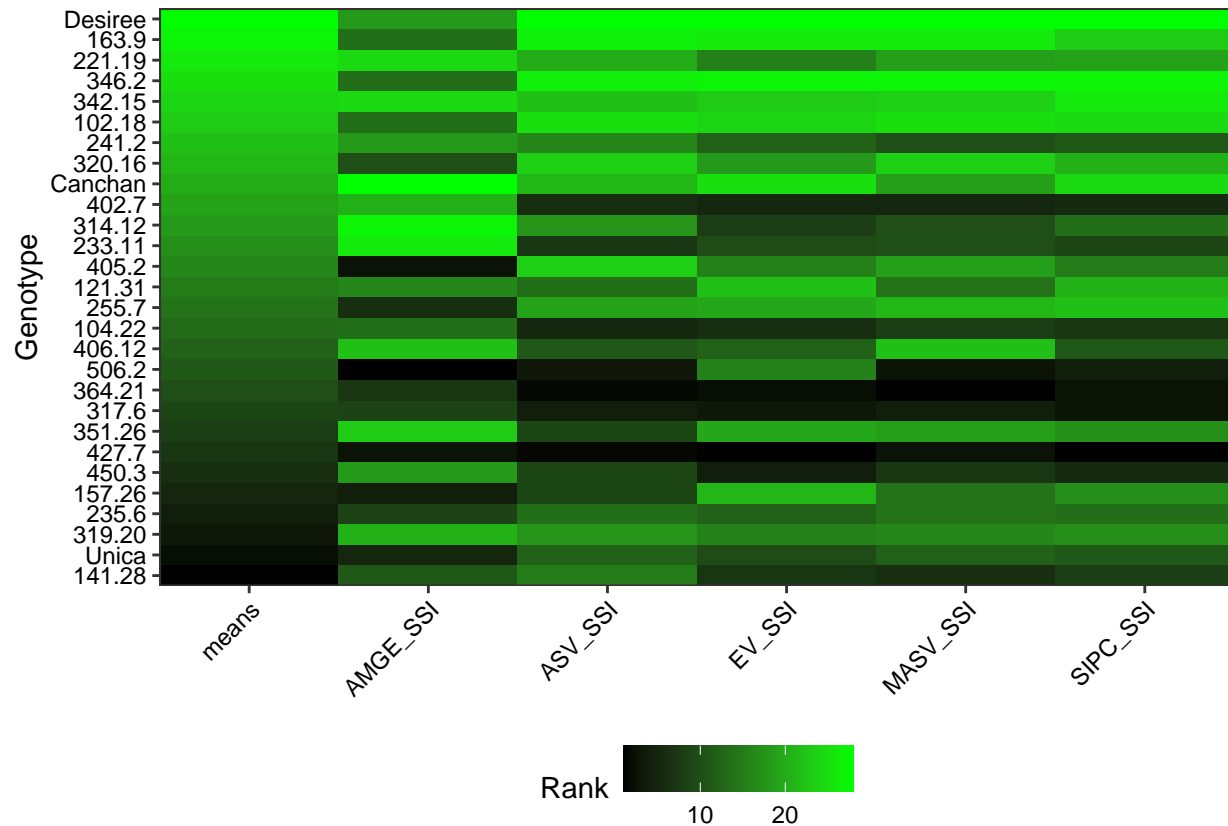
Slopegraph of ranks of mean yields and simultaneous selection indices



\$`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.
<http://www.isgpb.org/article/ammistability-r-package-for-ranking-genotypes-based-on-stability-paramet>

A BibTeX entry for LaTeX users is

```
@Article{,
  title = {ammistability: {R} package for ranking genotypes based on stability parameters derived from},
  author = {B. C. Ajay and J. Aravind and R. {Abdul Fiyaz}},
  journal = {Indian Journal of Genetics and Plant Breeding (The)},
  year = {2019},
  volume = {79},
  number = {2},
  pages = {460--466},
  url = {http://www.isgpb.org/article/ammistability-r-package-for-ranking-genotypes-based-on-stabilit},
}
```

Ajay, B. C., Aravind, J., and Abdul Fiyaz, R. (2021). *ammistability*: Additive Main Effects and Multiplicative Interaction Model Stability Parameters. R package version 0.1.1.9000,
<https://ajaygpb.github.io/ammistability/>, <https://CRAN.R-project.org/package=ammistability>.

A BibTeX entry for LaTeX users is

```
@Manual{,
  title = {ammistability: Additive Main Effects and Multiplicative Interaction Model Stability Parameters},
  author = {B. C. Ajay and J. Aravind and R. {Abdul Fiyaz}},
  year = {2021},
  note = {R package version 0.1.1.9000},
  note = {https://ajaygpb.github.io/ammistability/},
  note = {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.

Session Info

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sessionInfo()
```

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R Under development (unstable) (2021-02-02 r79929)
```

```
Platform: x86_64-w64-mingw32/x64 (64-bit)
```

```
Running under: Windows 10 x64 (build 19041)
```

```
Matrix products: default
```

```
locale:
```

```
[1] LC_COLLATE=English_India.1252 LC_CTYPE=English_India.1252 LC_MONETARY=English_India.1252
```

```
[4] LC_NUMERIC=C LC_TIME=English_India.1252
```

```
attached base packages:
```

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

```
other attached packages:
```

```
[1] agricolae_1.3-3      ammistability_0.1.1.9000
```

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

```
[1] Rcpp_1.0.6      lattice_0.20-41  assertthat_0.2.1  rprojroot_2.0.2  digest_0.6.27    mime_0.9.6
[7] plyr_1.8.6      R6_2.5.0        AlgDesign_1.2.0   ggcorrplot_0.1.3 labelled_2.7.0    evaluate_0.14.0
[13] httr_1.4.2      ggplot2_3.3.3    highr_0.8         pillar_1.4.7     Rdpack_2.1        rlang_0.4.13
[19] curl_4.3        rstudioapi_0.13  miniUI_0.1.1.1    combinat_0.0-8   rmarkdown_2.6     pkgdown_2.0.6
[25] labeling_0.4.2  desc_1.2.0       stringr_1.4.0     questionr_0.7.4  pander_0.6.3      RCurl_1.95-1.1
[31] munsell_0.5.0   shiny_1.6.0      compiler_4.1.0    httpuv_1.5.5     xfun_0.20         pkgconfig_2.0.3
[37] htmltools_0.5.1.1 tidyselect_1.1.0  tibble_3.0.6      XML_3.99-0.5     crayon_1.4.0      dplyr_1.0.7
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[79] haven_2.3.1
```

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. Available at: <https://www.isgpb.org/article/ammistability-r-package-for-ranking-genotypes-based-on-stability-parameters-derived-from-ammi-model>.
- 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: <http://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](https://doi.org/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.
- 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](https://doi.org/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: http://www.crri.nic.in/CRRI_newsletter/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](https://doi.org/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: <http://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](https://doi.org/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](https://doi.org/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. Available at: <http://eprints.icrisat.ac.in/id/eprint/7173>.
- Zhang, Z., Lu, C., and Xiang, Z. (1998). Analysis of variety stability based on AMMI model. *Acta Agronomica Sinica* 24, 304–309. Available at: <http://zwx.b.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.