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SUPPLEMENTARY INFORMATION
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Multiple facets of biodiversity drive the diversity–stability relationship

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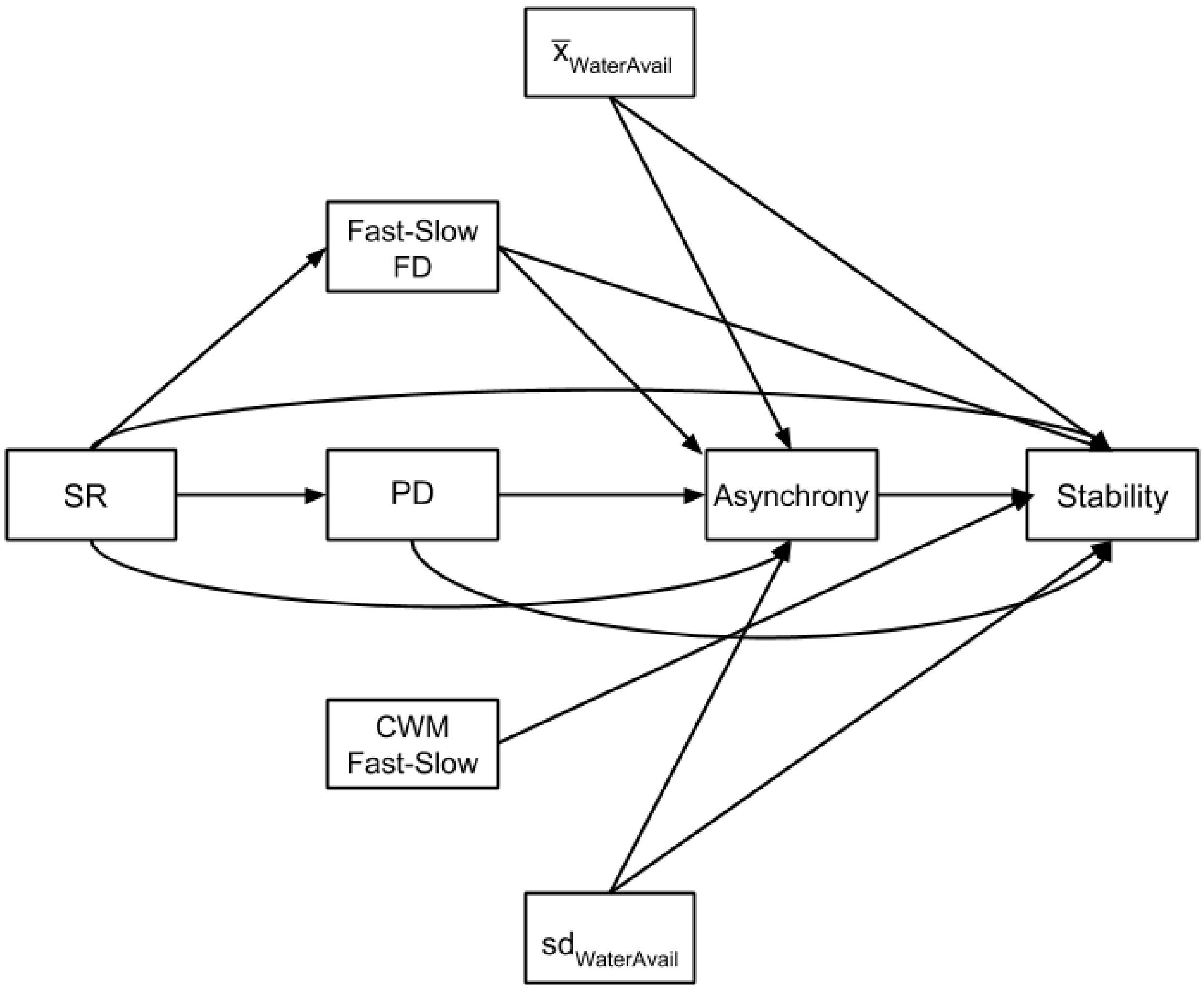
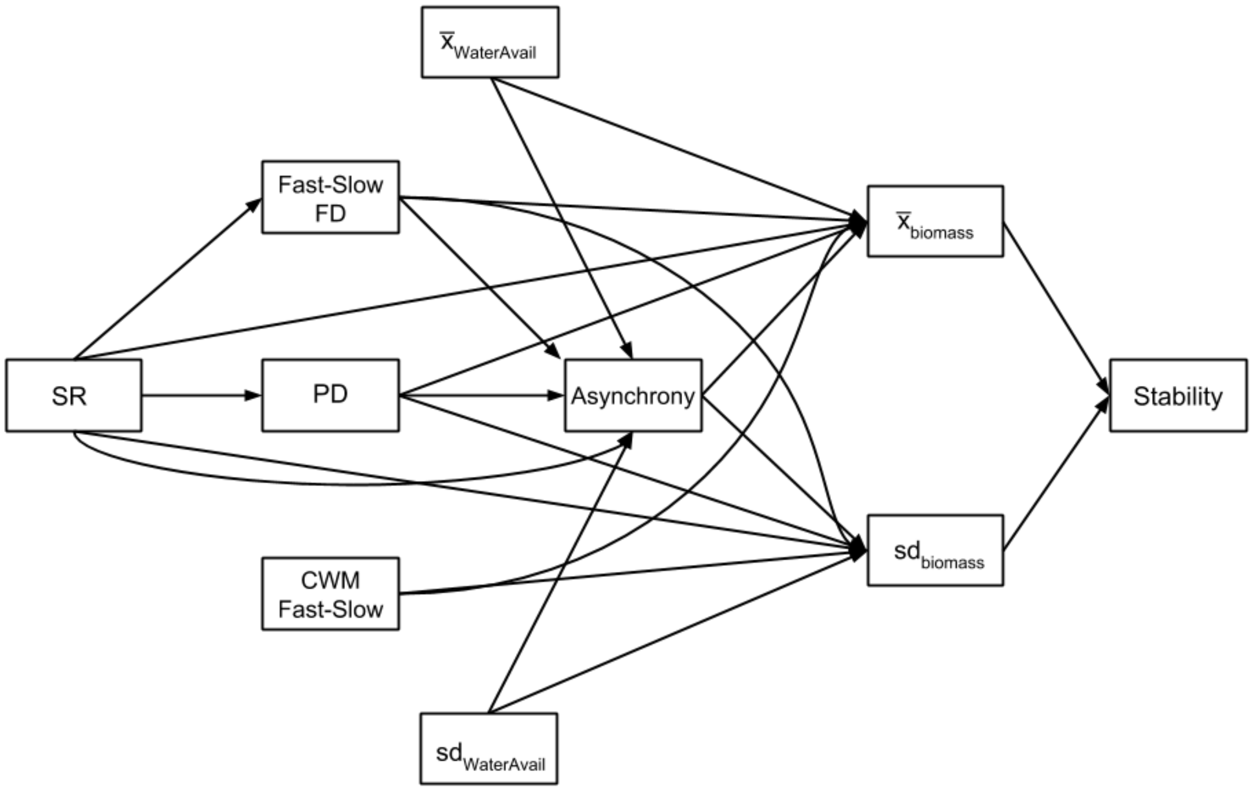
Supplementary Information

Multiple facets of biodiversity drive the diversity-stability relationship

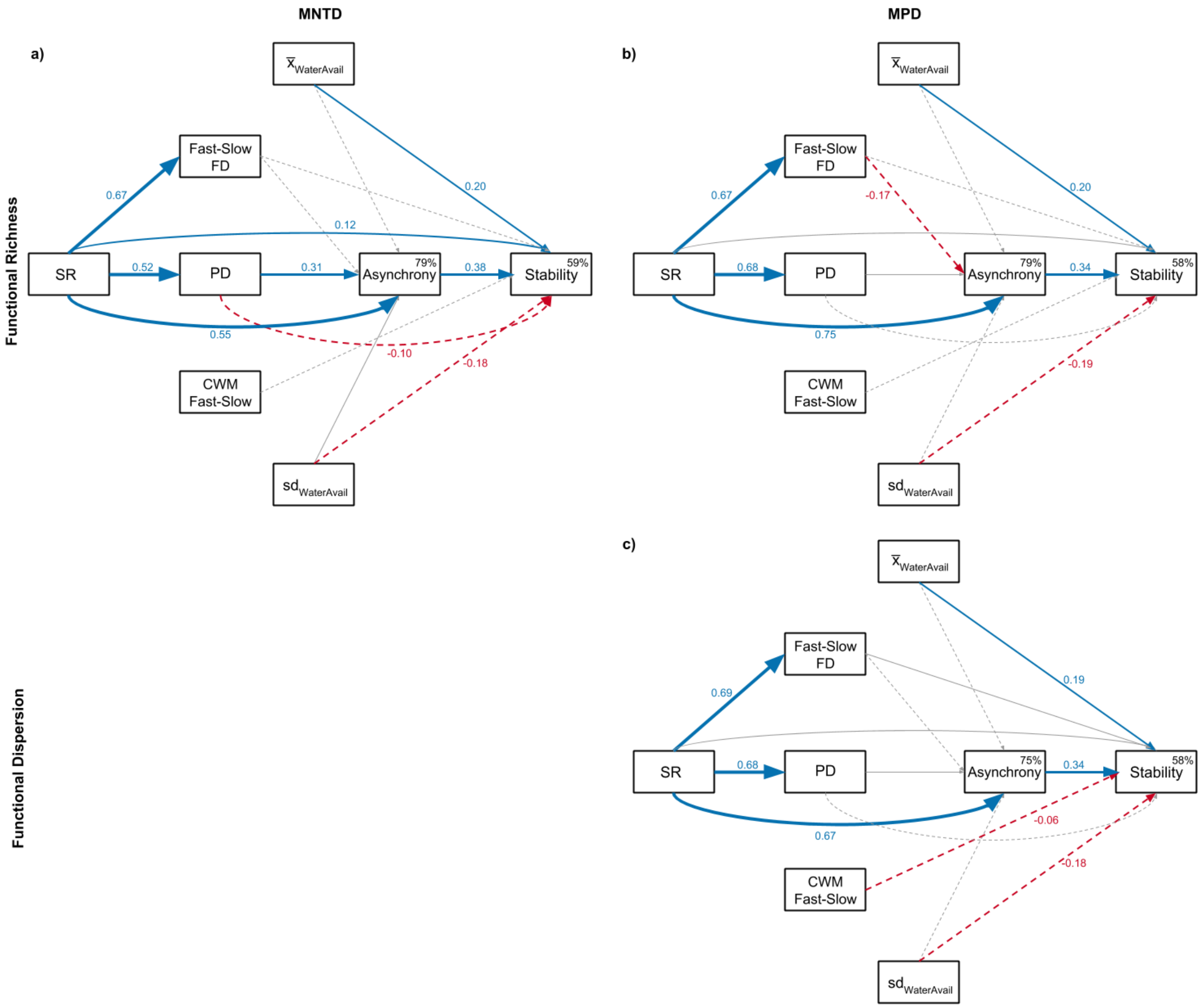
Dylan Craven, Nico Eisenhauer , William D. Pearse, Yann Hautier, Forest Isbell, Christiane Roscher, Michael Bahn, Carl Beierkuhnlein, Gerhard Bönisch, Nina Buchmann, Chaeho Byun, Jane A. Catford, Bruno E.L. Cerabolini, J. Hans C. Cornelissen, Joseph M. Craine, Enrica De Luca, Anne Ebeling, John N. Griffin, Andy Hector, Jes Hines, Anke Jentsch, Jens Kattge, Jürgen Kreyling, Vojtech Lanta, Nathan Lemoine, Sebastian T. Meyer, Vanessa Minden, Vladimir Onipchenko, H. Wayne Polley, Peter B. Reich, Jasper van Ruijven, Brandon Schamp, Melinda D. Smith, Nadejda A. Soudzilovskaia, David Tilman, Alexandra Weigelt, Brian Wilsey, Peter Manning



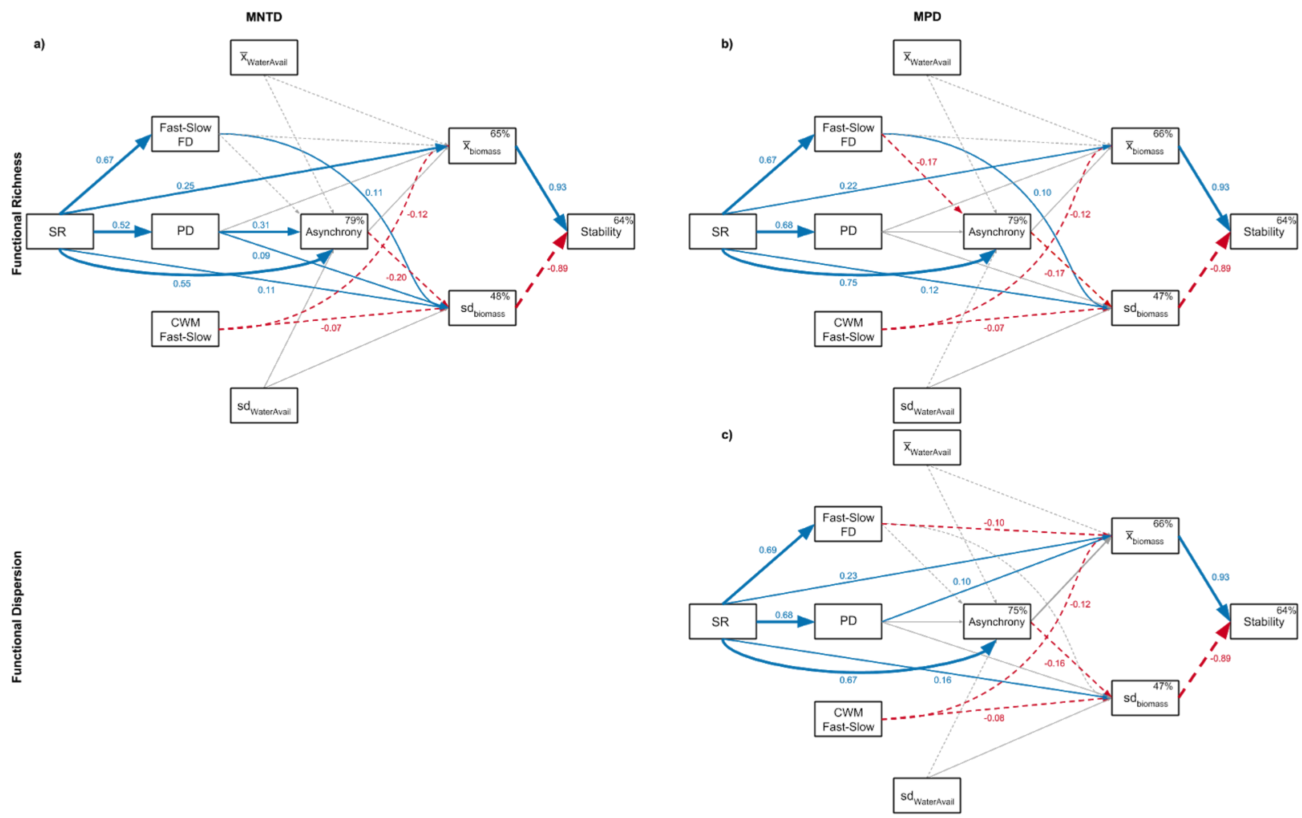
Supplementary Figure 1. Hypothetical causal model for structural equation model (SEM) exploring the effects of plant species richness (SR), fast-slow functional diversity (Fast-Slow FD), phylogenetic diversity (PD), community-weighted mean of fast-slow traits (CWM Fast-Slow), mean ($\overline{x}_{WaterAvail}$) and variation in water availability ($sd_{WaterAvail}$) on species asynchrony (Asynchrony) and ecosystem stability of aboveground biomass production (Stability) in experimental grassland studies. Black lines are hypothesized paths.



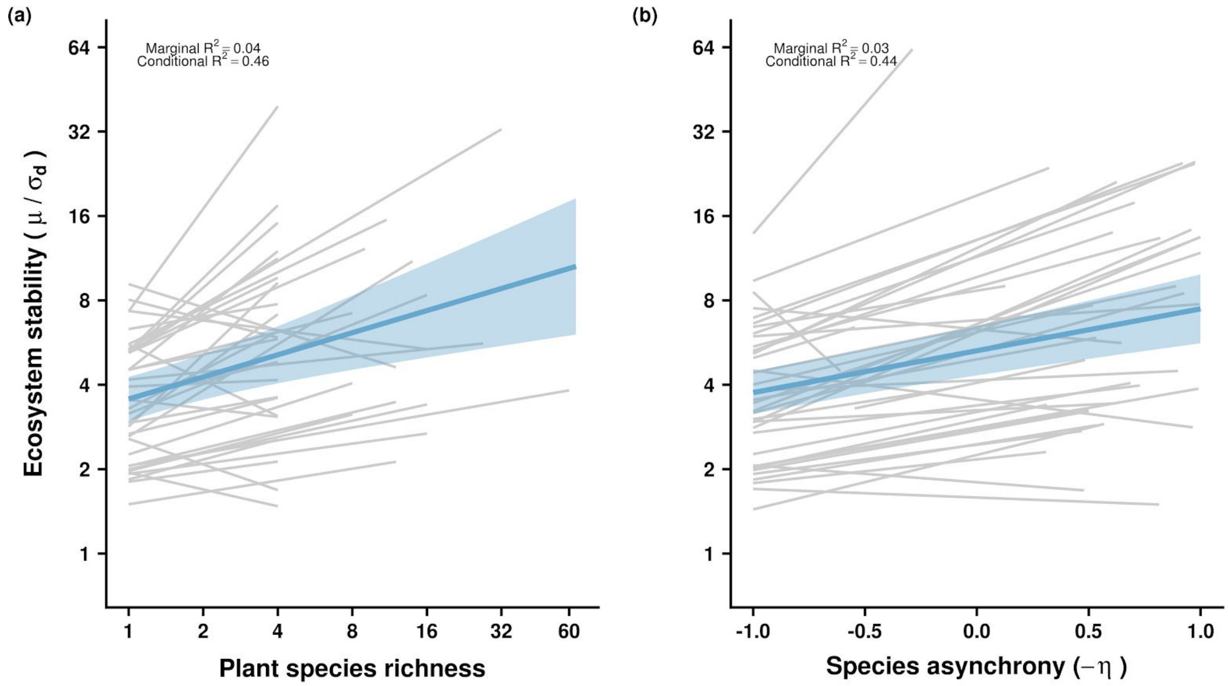
Supplementary Figure 2. Hypothetical causal model for structural equation model (SEM) exploring the effects of plant species richness (SR), fast-slow functional diversity (Fast-Slow FD), phylogenetic diversity (PD), community-weighted mean of fast-slow traits (CWM Fast-Slow), mean ($\bar{x}_{WaterAvail}$) and inter-annual variation in water availability ($sd_{WaterAvail}$) on species asynchrony (Asynchrony), mean ($\bar{x}_{biomass}$) and variation in ($SD_{biomass}$) aboveground biomass production, and ecosystem stability of aboveground biomass production (Stability) in experimental grassland studies. Black lines are hypothesized paths.



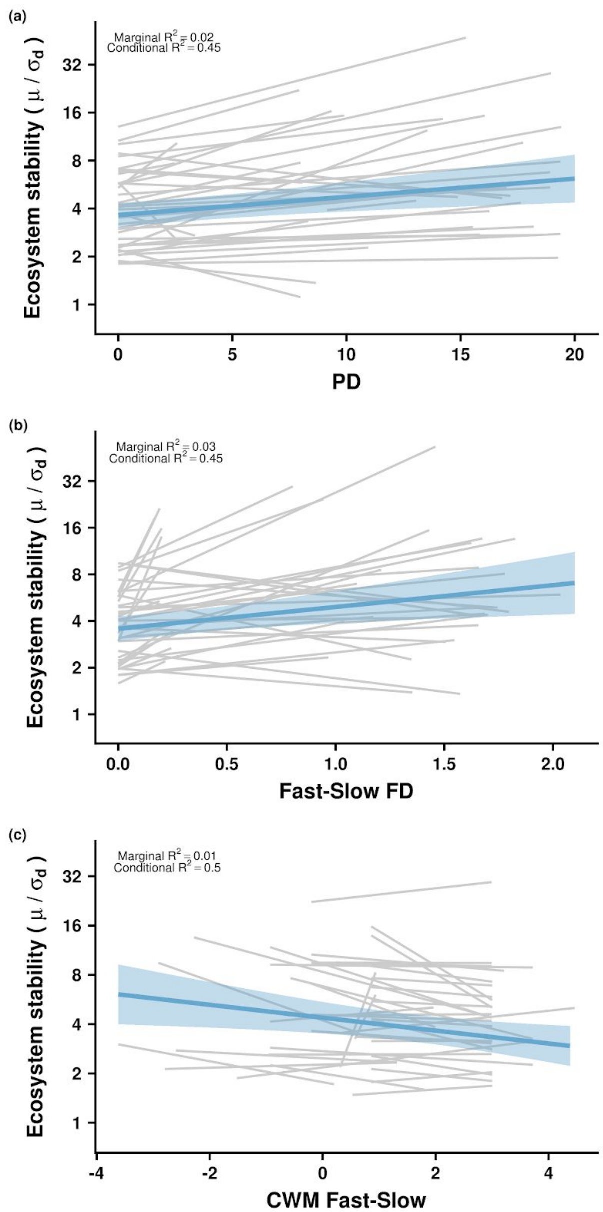
Supplementary Figure 3. Structural equation models (SEM) exploring the effects of plant species richness (SR), fast-slow functional diversity (Fast-slow FD), phylogenetic diversity (PD), community-weighted mean of fast-slow traits (CWM Fast-Slow), mean ($\bar{x}_{WaterAvail}$) and variation in water availability ($sd_{WaterAvail}$) on species asynchrony and ecosystem stability of aboveground biomass production across 39 experimental grassland studies using different combinations of functional and phylogenetic diversity indices (**a**, *functional richness* and *mean nearest taxon phylogenetic distance* (MNTD); **b**, *functional richness* and *mean pairwise phylogenetic distance* (MPD); **c**, *functional dispersion* and *MNTD)*. For **a**, the model fit the data well (Fisher’ C = 12.57, df = 12, P = 0.40, K = 34, n = 1,699), as was the case for **b** (Fisher’s C = 9.29, df = 10, *P* = 0.50, k = 34, n = 1,699) and **c** (Fisher’s C = 5.21, df = 10, P = 0.88, k = 34, n = 1,699)**.** Boxes represent measured variables and arrows represent relationships among variables. Solid blue and dashed red arrows represent significant ($P \leq 0.05$), positive and negative standardized path coefficients, respectively, and gray arrows represent non-significant standardized path coefficients. Standardized path coefficients are given next to each (significant) path; widths of significant paths are scaled by standardized path coefficients. The conditional R^2 (based on both fixed and random effects) for asynchrony and ecosystem stability is reported in the corresponding box.



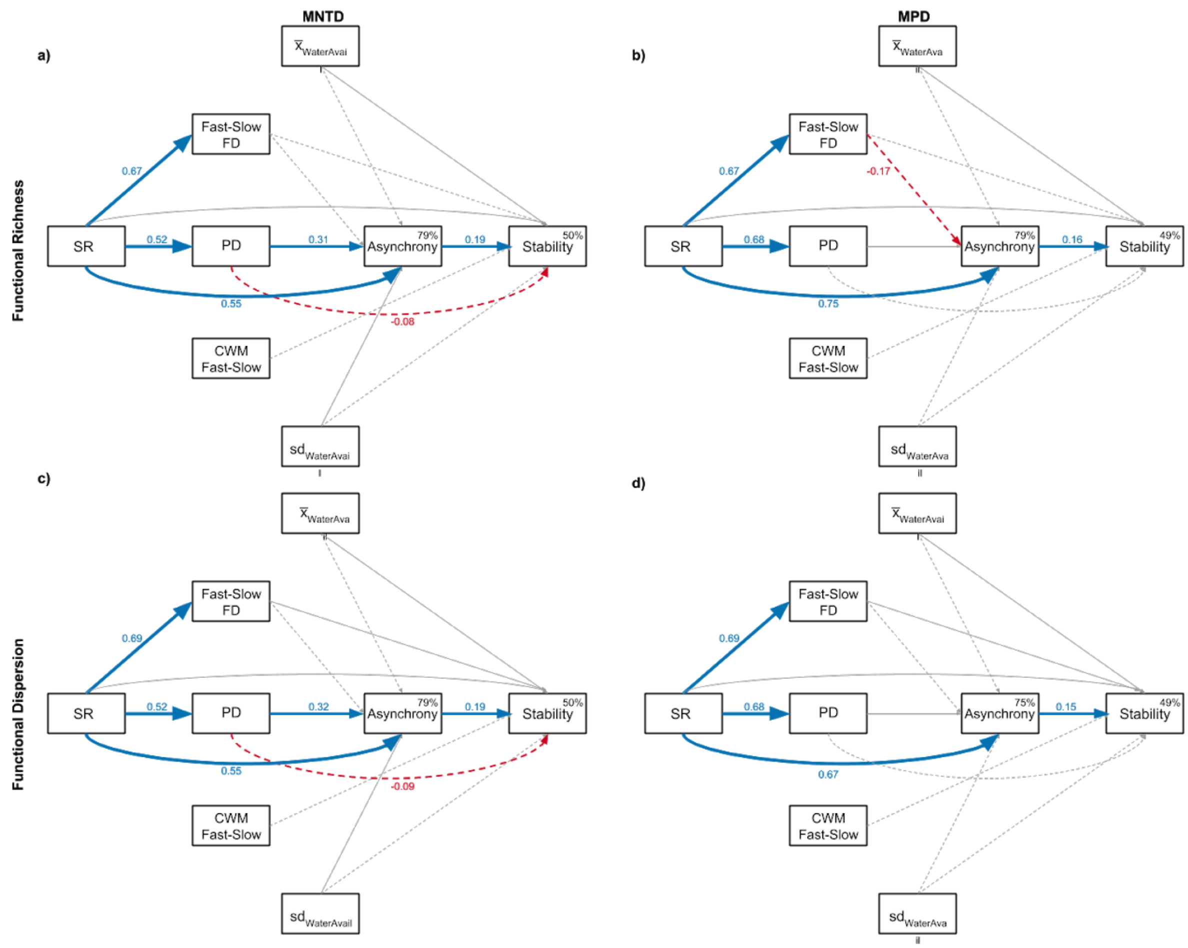
Supplementary Figure 4. Structural equation models (SEM) exploring the effects of plant species richness (SR), fast-slow functional diversity (Fast-Slow FD), phylogenetic diversity (PD), community-weighted mean of fast-slow traits (CWM Fast-Slow), mean ($\overline{x}_{WaterAvail}$) and variation in water availability (sd$_{WaterAvail}$) on species asynchrony, mean ($\overline{x}_{biomass}$) and variation in (SD $_{biomass}$) aboveground biomass production and ecosystem stability of aboveground biomass production across 39 experimental grassland studies using different combinations of functional and phylogenetic diversity indices (**a**, *functional richness* and *mean nearest taxon phylogenetic distance* (MNTD); **b**, *functional richness* and *mean pairwise phylogenetic distance* (MPD); **c**, *functional dispersion* and *MNTD)*. For **a**, the model fit the data well (Fisher' C = 26.83, df = 22, P = 0.22, K = 49, n =1,699), as was the case for **b** (Fisher's C = 23.67, df = 20, P = 0.26, k =49, n = 1,699) and **c** (Fisher's C = 19.93, df = 20, P = 0.46, k = 49, n = 1,699)**.** Boxes represent measured variables and arrows represent relationships among variables. Solid blue and dashed red arrows represent significant (P ≤ 0.05), positive and negative standardized path coefficients, respectively, and gray arrows represent non-significant standardized path coefficients. Standardized path coefficients are given next to each (significant) path; widths of significant paths are scaled by standardized path coefficients. The conditional R^2 (based on both fixed and random effects) for asynchrony and ecosystem stability is reported in the corresponding box.



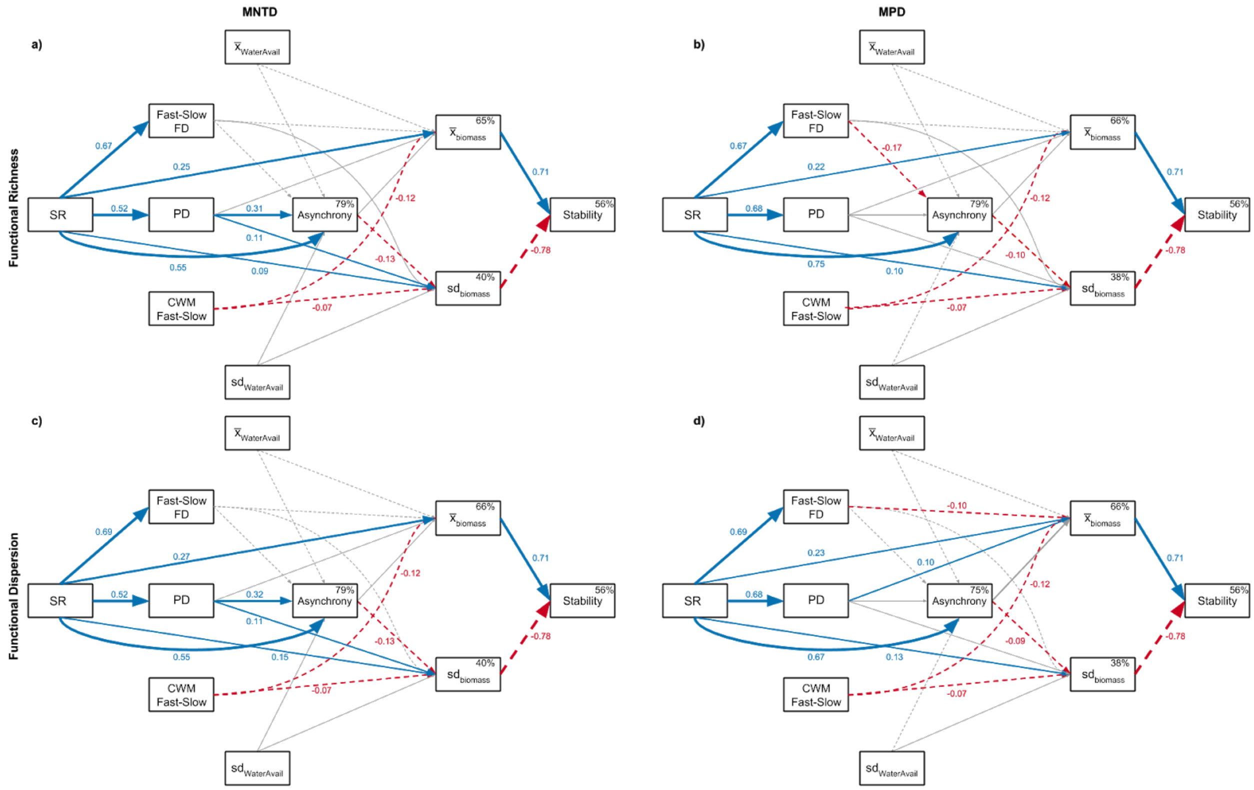
Supplementary Figure 5. Plant species richness (**a**) and species asynchrony (**b**) effects on *detrended ecosystem stability* of aboveground biomass production across 39 experimental grassland studies. Lines are mixed-effects model fits for each study (light gray lines) or across all studies (black lines; $P \leq 0.05$). Synchrony ranges from -1 to 1, where -1 represents maximum synchrony and +1 maximum asynchrony. Marginal and conditional R^2 represent model variation explained by fixed effects and the combination of fixed and random effects, respectively. Light blue bands represents 95% confidence intervals.



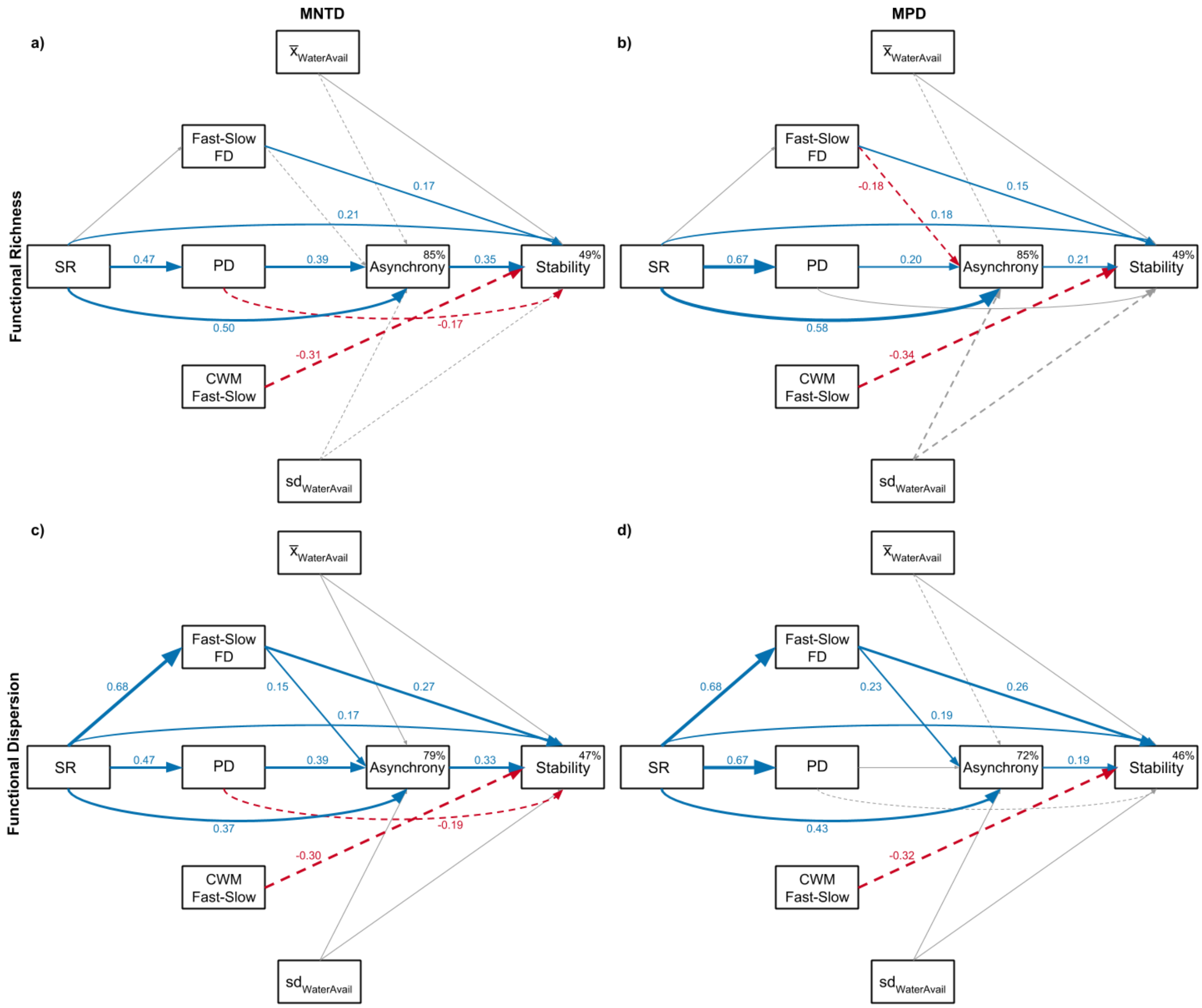
Supplementary Figure 6. Phylogenetic (**a**; PD) and fast-slow functional diversity (**b;** Fast-Slow FD) and community-weighted mean of fast-slow traits (**c;** CWM Fast-Slow) effects on *detrended ecosystem stability* of aboveground biomass production across 39 experimental grassland studies. Phylogenetic diversity is abundance-weighted mean nearest taxon distance (MNTD) and Fast-Slow FD is abundance-weighted functional dispersion of fast-slow traits. CWM Fast-Slow is the first axis of a principal component analysis of community-weighted means of key leaf functional traits associated with 'fast' and 'slow' ecological strategies: specific leaf area (SLA), leaf matter dry content (LMDC), and leaf N and P concentrations. Low values of the fast-slow spectrum correspond to communities dominated by 'slow' species, i.e. low SLA and leaf N and P and high LDMC and high values to communities dominated 'fast species, i.e. high SLA and leaf N and P and low LDMC. Lines are mixed-effects model fits for each study (light gray lines) or across all studies (black lines; $P \leq 0.05$). Marginal and conditional R^2 represent model variation explained by fixed effects and the combination of fixed and random effects, respectively. Light blue bands represents 95% confidence intervals.



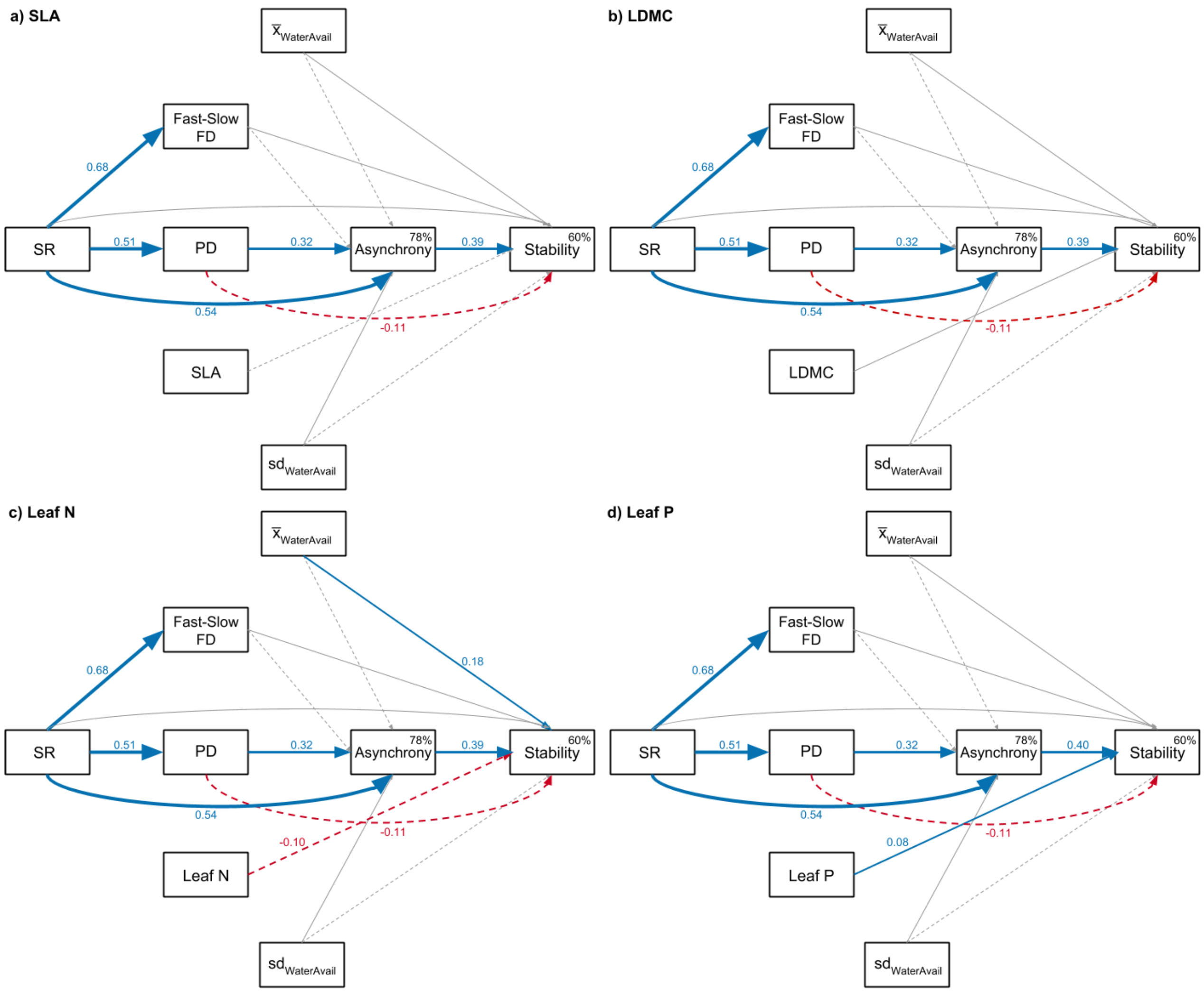
Supplementary Figure 7. Structural equation models (SEM) exploring the effects of plant species richness (SR), fast-slow functional diversity (Fast-Slow FD), phylogenetic diversity (PD), functional composition (CWM Fast-Slow), mean ($\bar{x}_{\mathrm{WaterAvail}}$) and inter-annual variation in water availability ($\mathrm{sd}_{\mathrm{WaterAvail}}$) on species asynchrony and *detrended ecosystem stability* of aboveground biomass production across 39 experimental grassland studies using different combinations of functional and phylogenetic diversity indices (**a**, *functional richness* and *mean nearest taxon phylogenetic distance* (MNTD); **b**, *functional richness* and *mean pairwise phylogenetic distance* (MPD); **c**, *functional dispersion* and *MNTD*; **d,** *functional dispersion* and *MPD*). For **a**, the model fit the data well (Fisher' C = 12.57, df = 12, P = 0.40, K = 34, n = 1,699), as was the case for **b** (Fisher's C = 9.29, df = 10, P = 0.50, k = 49, n = 1,699), **c** (Fisher's C = 7.51, df = 12, P = 0.82, k = 34, n = 1,699), and **d** (Fisher's C = 5.21, df = 10, P = 0.88, k = 34, n = 1,699)**.** Boxes represent measured variables and arrows represent relationships among variables. Solid blue and dashed red arrows represent significant ($P \leq 0.05$), positive and negative standardized path coefficients, respectively, and gray arrows represent non-significant standardized path coefficients. Standardized path coefficients are given next to each (significant) path; widths of significant paths are scaled by standardized path coefficients. The conditional R^2 (based on both fixed and random effects) for asynchrony and ecosystem stability is reported in the corresponding box.



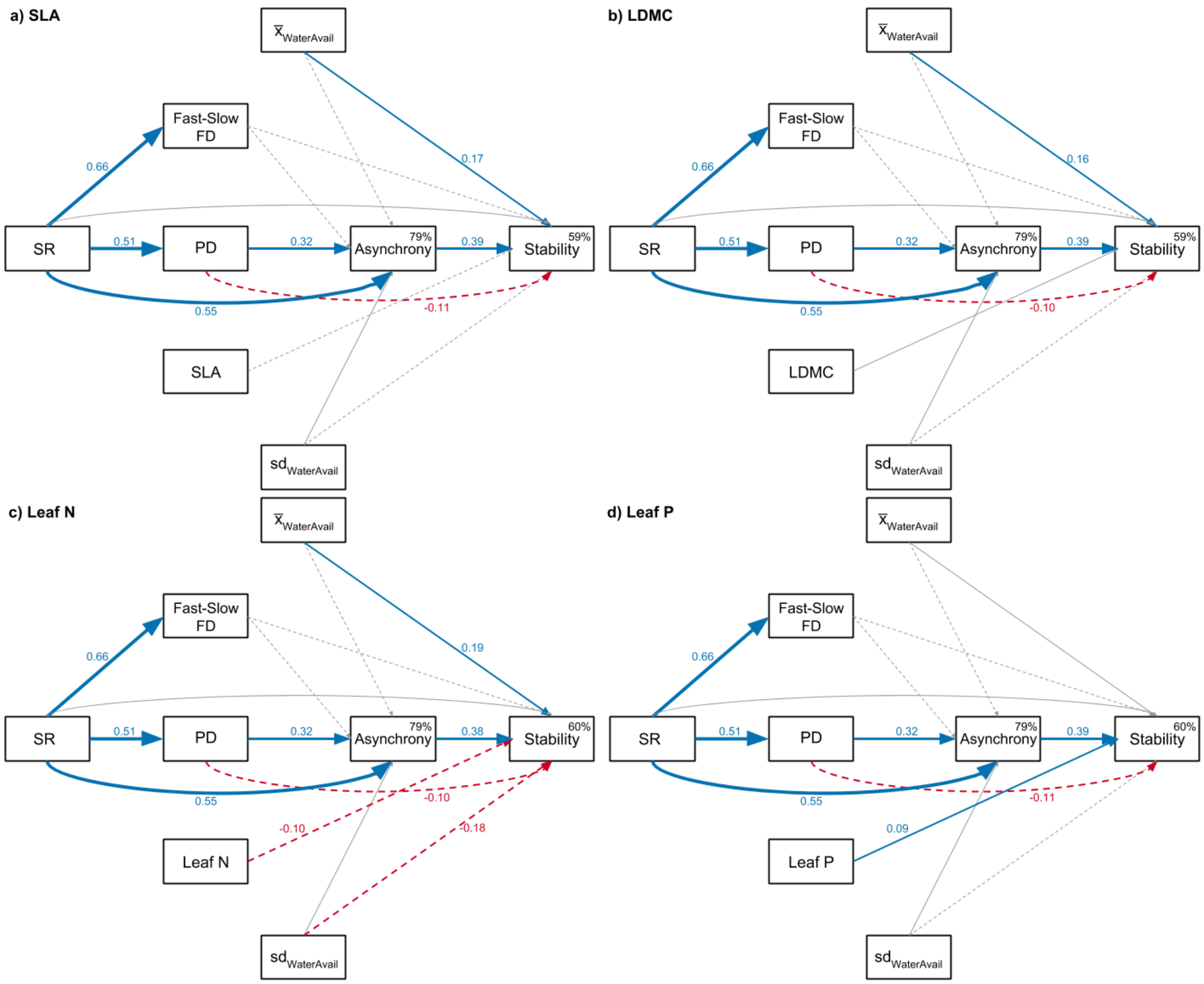
Supplementary Figure 8. Structural equation models (SEM) exploring the effects of plant species richness (SR), fast-slow functional diversity (Fast-Slow FD), phylogenetic diversity (PD), functional composition (CWM Fast-Slow), mean ($\overline{x}_{\text{WaterAvail}}$) and inter-annual variation in water availability ($sd_{\text{WaterAvail}}$) on species asynchrony, mean ($\overline{x}_{\text{biomass}}$) and variation in (detrended sd $_{\text{biomass}}$) aboveground biomass production and *detrended ecosystem stability* of aboveground biomass production across 39 experimental grassland studies using different combinations of functional and phylogenetic diversity indices (**a**, *functional richness* and *mean nearest taxon phylogenetic distance* (MNTD); **b**, *functional richness* and *mean pairwise phylogenetic distance* (MPD); **c**, *functional dispersion* and *MNTD*; **d,** *functional dispersion* and *MPD*). For **a**, the model fit the data well (Fisher' C =17.39, df = 22, P = 0.74, K = 49, n = 1,699), as was the case for **b** (Fisher's C = 14.26, df = 20, P = 0.82, k = 49, n = 1,699), **c** (Fisher's C = 13.06, df = 22, P = 0.93, k = 49, n = 1,699), and **d** (Fisher's C = 10.8, df = 20, P = 0.95, k = 49, n = 1,699)**.** Boxes represent measured variables and arrows represent relationships among variables. Solid blue and dashed red arrows represent significant ($P \leq 0.05$), positive and negative standardized path coefficients, respectively, and gray arrows represent non-significant standardized path coefficients. Standardized path coefficients are given next to each (significant) path; widths of significant paths are scaled by standardized path coefficients. The conditional R^2 (based on both fixed and random effects) for asynchrony and ecosystem stability is reported in the corresponding box.



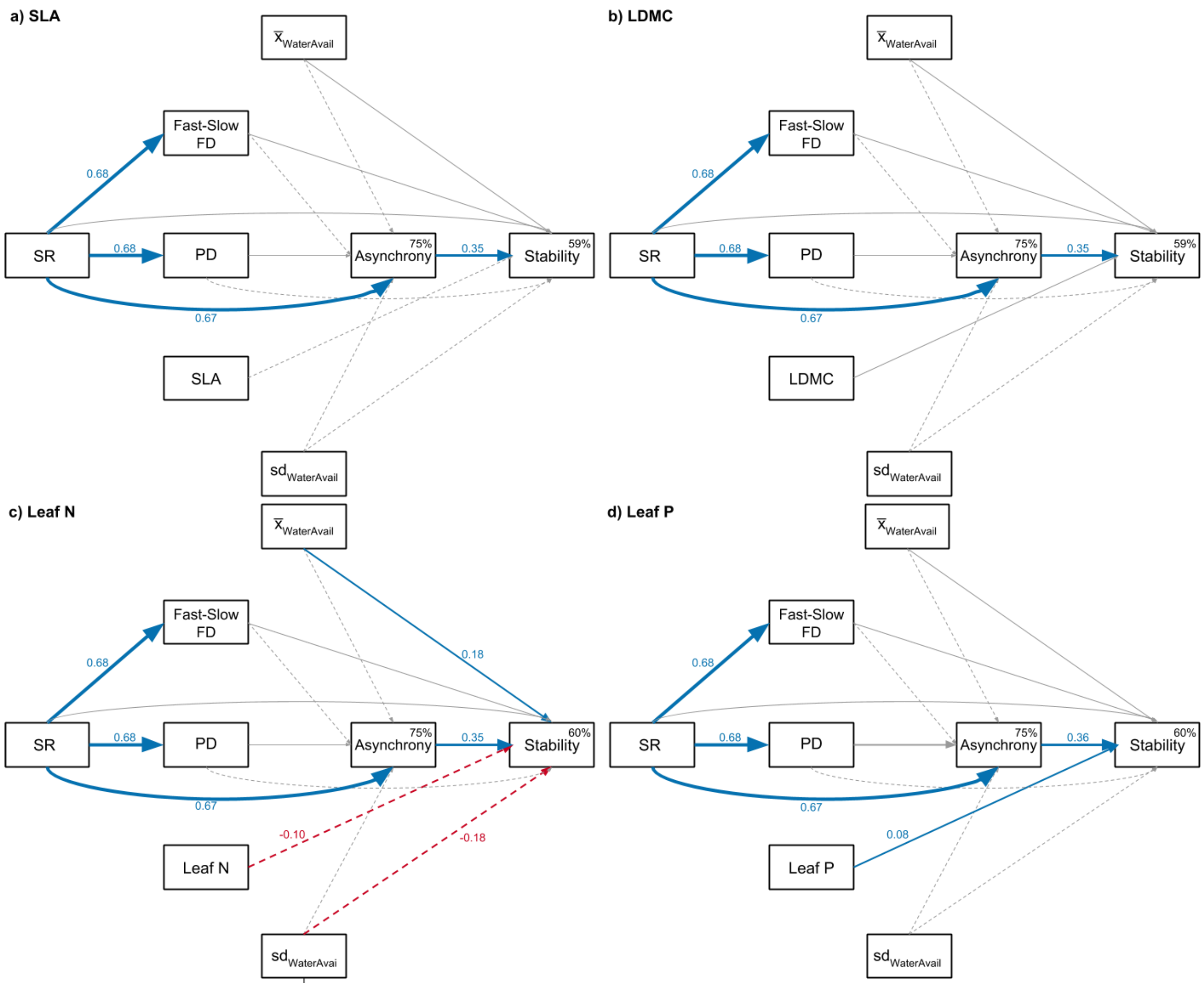
Supplementary Figure 9. Structural equation models (SEM) exploring the effects of plant species richness (SR), functional diversity (FD), phylogenetic diversity (PD), community-weighted mean of fast-slow traits (Fast-Slow), mean and ($\overline{x}_{\text{WaterAvail}}$) variation in water availability ($sd_{\text{WaterAvail}}$) on species asynchrony and ecosystem stability of aboveground biomass production across six *long-term* experimental grassland studies (> 4 years) using all possible combinations of functional and phylogenetic diversity indices (**a**, *functional richness* and *mean nearest taxon phylogenetic distance* (MNTD); **b**, *functional richness* and *mean pairwise phylogenetic distance* (MPD); **c**, *functional dispersion* and *MNTD*; **d**, *functional dispersion* and *MPD*). For **a**, the model fit the data well (Fisher' C = 13.46, df = 10, P = 0.20, K = 34, n = 454), as was the case for **b** (Fisher's C = 9.80, df = 12, P = 0.63, k = 34, n = 454), **c** (Fisher's C = 14.25, df = 10, P = 0.16, k = 34, n = 454), and **d** (Fisher's C = 12.08, df = 12, P = 0.44, k = 34, n = 454). Boxes represent measured variables and arrows represent relationships among variables. Solid blue and dashed red arrows represent significant ($P \leq 0.05$), positive and negative standardized path coefficients, respectively, and gray arrows represent non-significant standardized path coefficients. The standardized path coefficient is given next to each (significant) path; widths of significant paths are scaled by standardized path coefficients. The conditional R^2 (based on both fixed and random effects) for asynchrony and ecosystem stability is reported in the corresponding box.



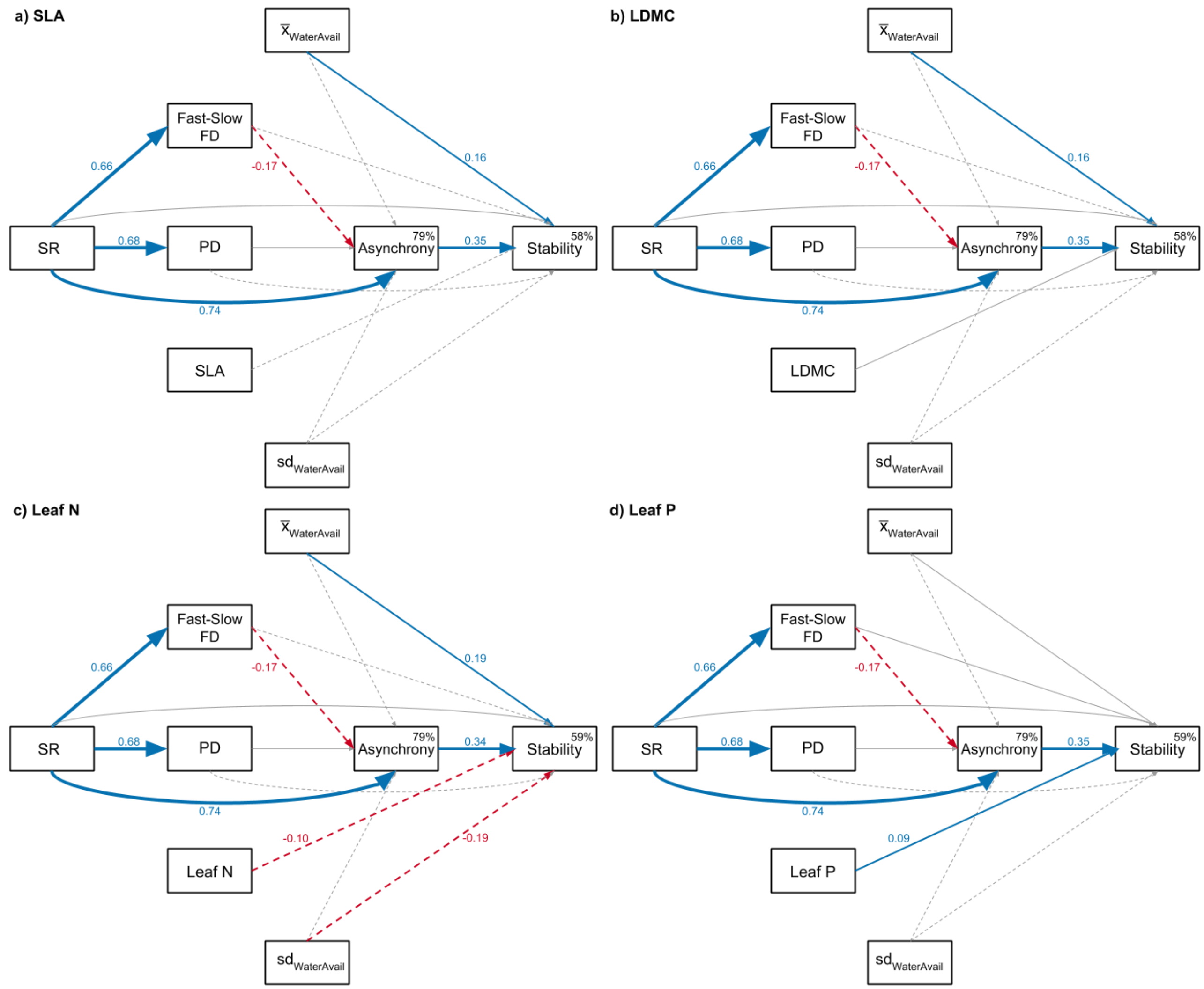
Supplementary Figure 10. Structural equation models (SEM) exploring the effects of plant species richness (SR), fast-slow functional diversity (Fast-Slow FD; *functional dispersion*), phylogenetic diversity (PD; *mean nearest taxon phylogenetic distance*), community-weighted means of fast-slow traits (**a**, SLA; **b**, LDMC; **c**, leaf N; **d**, leaf P), mean ($\bar{x}_{\mathrm{WaterAvail}}$) and variation in water availability ($sd_{\mathrm{WaterAvail}}$) on species asynchrony and ecosystem stability of aboveground biomass production across 39 experimental grassland studies. For **a**, the model fit the data well (Fisher' C = 7.88, df = 12, P = 0.79, K = 34, n = 1,598), as was the case for **b** (Fisher's C = 6.19, df = 10, P = 0.80, k = 34, n = 1,598), **c** (Fisher's C = 12.93, df = 14, P = 0.53, k = 34, n = 1,598), and **d** (Fisher's C = 12.40, df = 12, P = 0.41, k = 34, n = 1,598). Boxes represent measured variables and arrows represent relationships among variables. Solid blue and dashed red arrows represent significant ($P \leq 0.05$), positive and negative standardized path coefficients, respectively, and gray arrows represent non-significant standardized path coefficients. The standardized path coefficient is given next to each (significant) path; widths of significant paths are scaled by standardized path coefficients. The conditional R^2 (based on both fixed and random effects) for asynchrony and ecosystem stability is reported in the corresponding box.



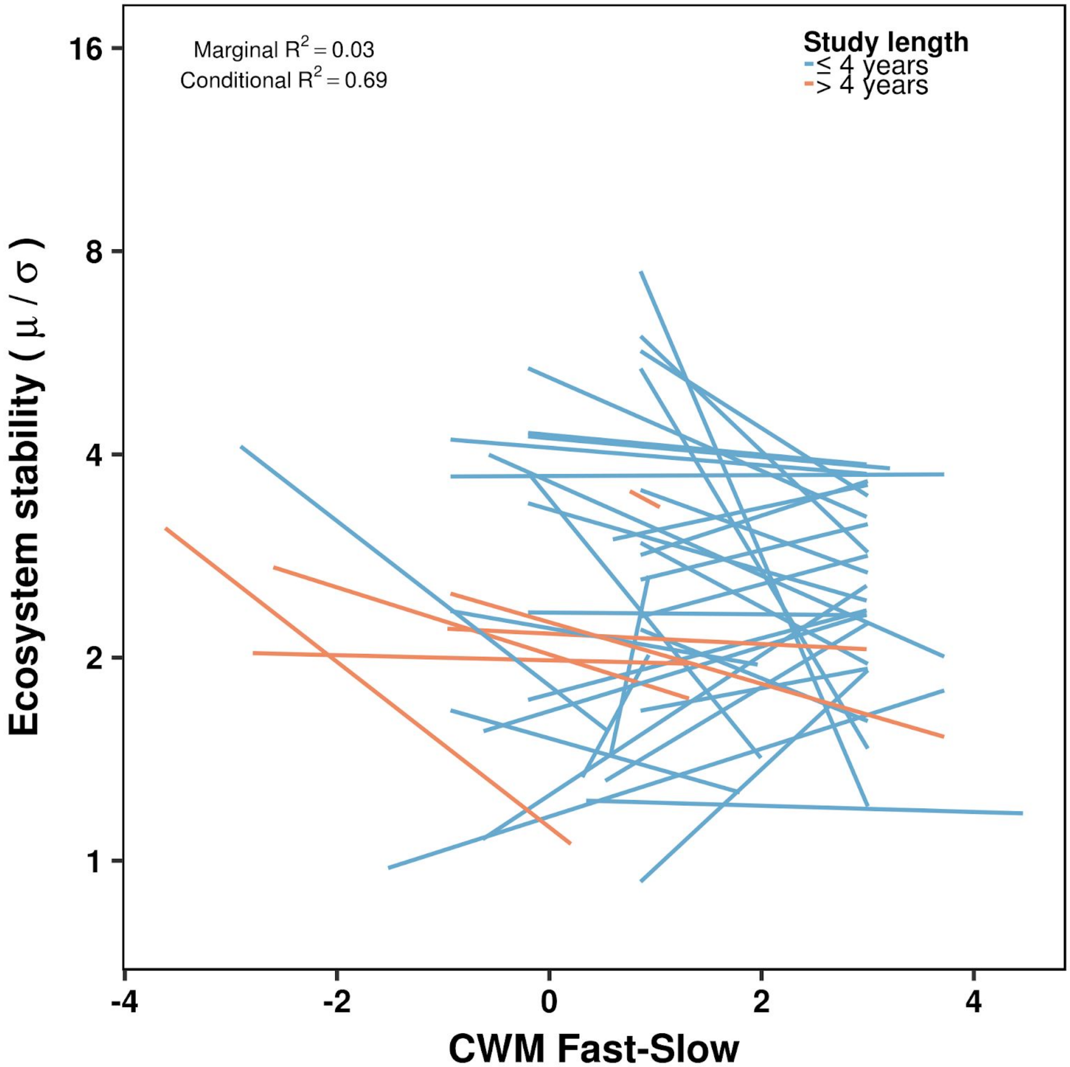
Supplementary Figure 11. Structural equation models (SEM) exploring the effects of plant species richness (SR), fast-slow functional diversity (Fast-Slow FD; *functional richness*), phylogenetic diversity (PD; *mean nearest taxon phylogenetic distance*), community-weighted means of fast-slow traits (**a**, SLA; **b**, LDMC; **c**, leaf N; **d**, leaf P), mean ($\overline{x}_{\mathrm{WaterAvail}}$) and variation in water availability ($sd_{\mathrm{WaterAvail}}$) on species asynchrony and ecosystem stability of aboveground biomass production across 39 experimental grassland studies. For **a**, the model fit the data well (Fisher' C = 9.35, df = 12, P = 0.67, K = 34, n = 1,598), as was the case for **b** (Fisher's C = 12.46, df = 12, P = 0.41, k = 34, n = 1,598), **c** (Fisher's C = 12.90, df = 12, P = 0.38, k = 34, n = 1,598), and **d** (Fisher's C = 16.41, df = 12, P = 0.17, k = 34, n = 1,598). Boxes represent measured variables and arrows represent relationships among variables. Solid blue and dashed red arrows represent significant ($P \leq 0.05$), positive and negative standardized path coefficients, respectively, and gray arrows represent non-significant standardized path coefficients. The standardized path coefficient is given next to each (significant) path; widths of significant paths are scaled by standardized path coefficients. The conditional R^2 (based on both fixed and random effects) for asynchrony and ecosystem stability is reported in the corresponding box.



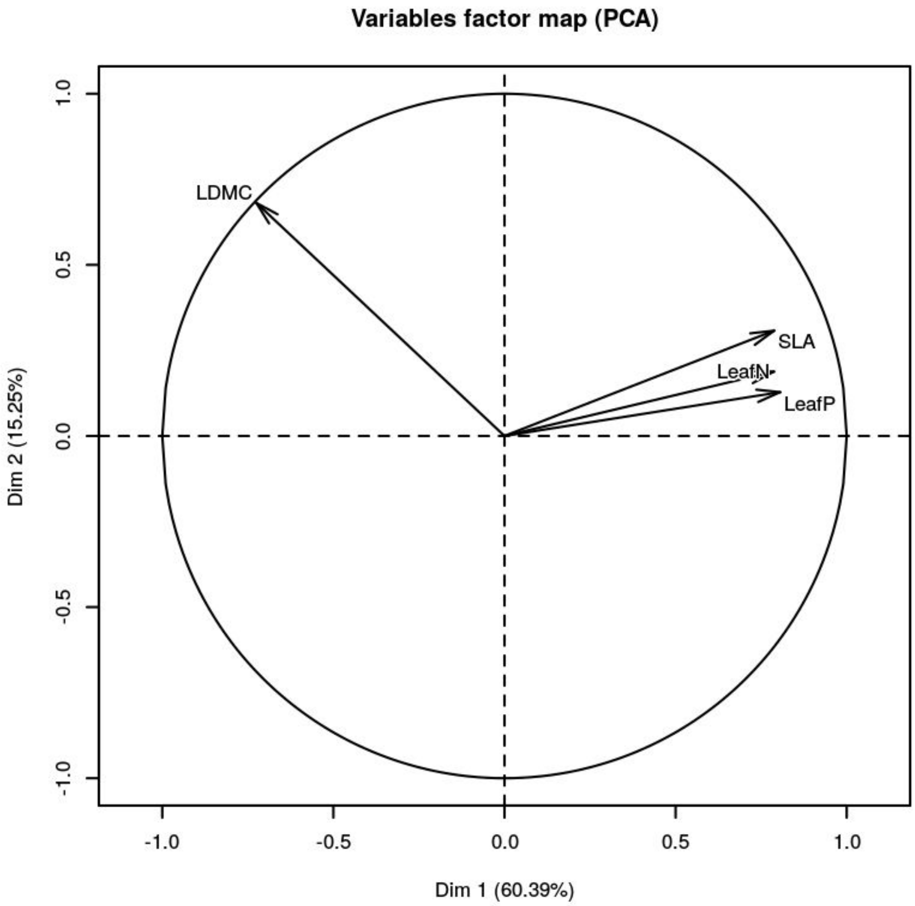
Supplementary Figure 12. Structural equation models (SEM) exploring the effects of plant species richness (SR), fast-slow functional diversity (Fast-Slow FD; *functional dispersion*), phylogenetic diversity (PD; *mean pairwise phylogenetic distance*), community-weighted means of fast-slow traits (**a**, SLA; **b**, LDMC; **c**, leaf N; **d**, leaf P), mean ($\bar{x}_{\text{WaterAvail}}$) and variation in water availability ($sd_{\text{WaterAvail}}$) on species asynchrony and ecosystem stability of aboveground biomass production across 39 experimental grassland studies. For **a**, the model fit the data well (Fisher' C = 8.93, df = 12, P = 0.71, K = 34, n = 1,598), as was the case for **b** (Fisher's C = 1.85, df = 10, P = 0.99, k = 34, n = 1,598), **c** (Fisher's C = 14.19, df = 14, P = 0.44, k = 34, n = 1,598), and **d** (Fisher's C = 8.31, df = 12, P = 0.76, k = 34, n = 1,598). Boxes represent measured variables and arrows represent relationships among variables. Solid blue and dashed red arrows represent significant ($P \leq 0.05$), positive and negative standardized path coefficients, respectively, and gray arrows represent non-significant standardized path coefficients. The standardized path coefficient is given next to each (significant) path; widths of significant paths are scaled by standardized path coefficients. The conditional R^2 (based on both fixed and random effects) for asynchrony and ecosystem stability is reported in the corresponding box.



Supplementary Figure 13. Structural equation models (SEM) exploring the effects of plant species richness (SR), fast-slow functional diversity (Fast-Slow FD; *functional richness*), phylogenetic diversity (PD; *mean pairwise phylogenetic distance*), community-weighted means of fast-slow traits (**a**, SLA; **b**, LDMC; **c**, leaf N; **d**, leaf P), mean ($\bar{x}_{\text{WaterAvail}}$) and variation in water availability ($\text{sd}_{\text{WaterAvail}}$) on species asynchrony and ecosystem stability of aboveground biomass production across 39 experimental grassland studies. For **a**, the model fit the data well (Fisher' C = 9.96, df = 12, P = 0.62, K = 34, n = 1,598), as was the case for **b** (Fisher's C = 8.20, df = 12, P = 0.77, k = 34, n = 1,598), **c** (Fisher's C = 13.40, df = 12, P = 0.34, k = 34, n = 1,598), and **d** (Fisher's C = 11.28, df = 12, P = 0.51, k = 34, n = 1,598). Boxes represent measured variables and arrows represent relationships among variables. Solid blue and dashed red arrows represent significant ($P \leq 0.05$), positive and negative standardized path coefficients, respectively, and gray arrows represent non-significant standardized path coefficients. The standardized path coefficient is given next to each (significant) path; widths of significant paths are scaled by standardized path coefficients. The conditional R^2 (based on both fixed and random effects) for asynchrony and ecosystem stability is reported in the corresponding box.



Supplementary Figure 14. Comparison of fast-slow leaf economics spectrum (CWM Fast-Slow) effects on ecosystem stability of aboveground biomass production between short- and long-term experimental grassland studies. We fit a mixed-effects model (similar to that used for Fig. 2) that included an interaction between the community-weighted mean of fast-slow traits and study length, but this interaction was not statistically significant ($P > 0.05$). Short-term studies are those lasting four or less years (blue lines) and long-term studies are those lasting longer than four years (red lines). CWM Fast-Slow is the first axis of a principal component analysis of community-weighted means of key leaf functional traits associated with 'fast' and 'slow' ecological strategies: specific leaf area (SLA), leaf matter dry content (LMDC), and leaf N and P concentrations (Supplementary Fig. 15). Low values of the fast-slow spectrum correspond to communities dominated by 'slow' species, i.e. low SLA and leaf N and P and high LDMC and high values to communities dominated 'fast species, i.e. high SLA and leaf N and P and low LDMC. Lines are mixed-effects model fits for each study. Marginal and conditional R^2 represent model variation explained by fixed effects and the combination of fixed and random effects, respectively.



Supplementary Figure 15. Bi-plot of principal components analysis (PCA) of community-weighted means of specific leaf area (SLA; mm^2 mg^{-1}), leaf dry matter content (LDMC; g g^{-1}) , foliar N (%), and foliar P (%). across 39 experimental grassland studies.

Supplementary Table 1. Fixed effects and model fit information for linear mixed-effects models of ecosystem stability of aboveground biomass production across 39 experimental grassland studies.

Fixed Effects	*L*	AICc	ICC	Marginal R^2	Conditional R^2
Species richness	**30.4**	3832.9	0.80	0.12	0.53
Functional Diversity	**22.6**	3845.8	0.60	0.04	0.57
Phylogenetic diversity	**22.4**	3850.6	0.56	0.03	0.49
CWM Fast-Slow	1.9	3827.3	0.76	0.01	0.68
Species asynchrony	**46.8**	3634.5	0.92	0.16	0.55

L is the χ^2 for likelihood ratio tests where values in bold are statistically significant at $\alpha = 0.05$, AIC_c is the small-sample-size corrected version of Akaike's information criterion; ICC is the intra-class correlation, and marginal and conditional R^2 represent model variation explained by fixed effects and the combination of fixed and random effects, respectively (See Supplementary Table 2 for variance components).

Supplementary Table 2. Variance components for linear mixed-effects models of ecosystem stability of aboveground biomass production across 39 experimental grassland studies.

Fixed Effect	**Variance Components**	**Variance**	**Standard Deviation**
Species Richness	Intercept	0.22	0.47
Species Richness	Species Richness	0.05	0.23
Species Richness	Residual	0.50	0.70
Asynchrony	Intercept	1.19	1.09
Asynchrony	Species Richness	0.11	0.33
Asynchrony	Asynchrony	0.90	0.95
Asynchrony	Species Richness:Asynchrony	0.31	0.55
Asynchrony	Residual	0.43	0.65
MNTD	Intercept	0.22	0.47
MNTD	Species Richness	0.18	0.42
MNTD	MNTD	0.00	0.06
MNTD	Species Richness: MNTD	0.00	0.05
MNTD	Residual	0.49	0.70
Functional dispersion	Intercept	0.22	0.47
Functional dispersion	Species Richness	0.15	0.39
Functional dispersion	Functional dispersion	0.08	0.29
Functional dispersion	Residual	0.49	0.70
Functional richness	Intercept	0.21	0.46
Functional richness	Species Richness	0.13	0.36
Functional richness	Functional richness	0.09	0.30
Functional richness	Species Richness:Functional richness	0.03	0.17
Functional richness	Residual	0.49	0.70
CWM Fast-Slow	Intercept	0.35	0.59
CWM Fast-Slow	Species Richness	0.11	0.34
CWM Fast-Slow	CWM Fast-Slow	0.07	0.27
CWM Fast-Slow	Residual	0.47	0.69

Supplementary Table 3. Fixed effects and model fit information for linear mixed-effects models of ecosystem stability of aboveground biomass production testing for differences between short- and long-term experimental grassland studies.

Fixed Effects	*L*	AICc	ICC	Marginal R^2	Conditional R^2
(1) Species richness	**30.4**	3839.7	0.80	0.13	0.53
Study length	1.0				
Species richness *x* Study length	0.0				
(2) Functional Diversity	**21.8**	3849.4	0.60	0.06	0.58
Study length	0.3				
Functional diversity *x* Study length	3.2				
(3) Phylogenetic diversity	**17.1**	3863.0	0.58	0.03	0.49
Study length	0.1				
Phylogenetic diversity *x* Study length	0.5				
(4) CWM Fast-Slow	1.5	3828.4	0.76	0.03	0.69
Study length	**3.9**				
CWM Fast-Slow x Study length	2.8				
(5) Species asynchrony	**46.7**	3640.6	0.92	0.17	0.55
Study length	0.8				
Species asynchrony *x* Study length	0.0				

L is the χ^2 for likelihood ratio tests where values in bold are statistically significant at $\alpha = 0.05$, AIC_c is the small-sample-size corrected version of Akaike's information criterion; ICC is the intra-class correlation, and marginal and conditional R^2 represent model variation explained by fixed effects and the combination of fixed and random effects, respectively. Numbers in parentheses refer to separate linear mixed-effects models. Study length was a binary variable with a value of one for studies that collected data for more than four years and a value of zero for all other studies.

Supplementary Table 4. Details of studies included in the analysis.

Study	Study length (y)	Sown Species Richness (range)	MAT	MAP	PET	Water Availability
Agrodiversity Belgium	3	1 - 4	10.9	815	796	1.03
Agrodiversity Canada	3	1 - 4	4.06	1,524	746	2.04
Agrodiversity France	3	1 - 4	13.76	631	1,018	0.62
Agrodiversity Iceland a	3	1 - 4	4.64	1,011	391	2.58
Agrodiversity Iceland b	3	1 - 4	4.42	1,002	385	2.60
Agrodiversity Ireland a	3	1 - 4	10.54	1,025	619	1.65
Agrodiversity Italy	3	1 - 4	15.94	640	990	0.65
Agrodiversity Lithuania a	3	1 - 4	6.99	601	680	0.88
Agrodiversity Lithuania b	3	1 - 4	7.17	600	688	0.87
Agrodiversity Lithuania c	3	1 - 4	7.17	600	688	0.87
Agrodiversity Netherlands	3	1 - 4	10.68	760	779	0.98
Agrodiversity Norway a	3	1 - 4	8.47	1,784	500	3.56
Agrodiversity Norway b	3	1 - 4	2.14	1,227	375	3.27
Agrodiversity Norway d	3	1 - 4	1.55	671	492	1.36
Agrodiversity Poland a	3	1 - 4	9.56	489	794	0.62
Agrodiversity Spain a	3	1 - 4	15.39	589	1,031	0.57
Agrodiversity Sweden a	3	1 - 4	7.34	761	659	1.16
Agrodiversity Sweden b	3	1 - 4	7.58	824	665	1.24
Agrodiversity Sweden c	3	1 - 4	3.13	562	494	1.14
Agrodiversity Switzerland	3	1 - 4	8.89	1,085	776	1.41

Agrodiversity Wales a	4	1 - 4	10.25	1,352	628	2.16
Agrodiversity Wales b	3	1 - 4	9.72	1,869	615	3.04
Cedar Creek Biodiversity	16	1 - 16	7.39	756	918	0.82
Cedar Creek BioCON	14	1 - 16	7.4	762	916	0.83
BIODEPTH Germany	3	1 - 16	7.76	590	754	0.78
BIODEPTH Ireland	3	1 - 8	10.6	1,091	632	1.73
BIODEPTH Portugal	3	1 - 14	17.43	763	1,066	0.72
BIODEPTH Sweden	3	1 - 12	3.39	555	435	1.30
BIODEPTH Switzerland	3	1 - 32	9.44	1,200	785	1.53
BIODEPTH Sheffield UK	3	1 - 12	8.76	1,080	620	1.75
BIODEPTH Silwood UK	3	1 - 11	10.06	696	745	0.94
EVENT	6	2 - 4	8.56	682	802	0.85
Hector UK	3	1 - 27	10.42	900	740	1.22
Jena	10	1 - 60	8.86	592	786	0.76
Czech Republic a	3	1 - 12	7.87	664	785	0.85
Czech Republic b	3	1 - 16	7.89	846	769	1.11
Texas MEND	3	1 - 9	19.91	801	1,516	0.53
Texas Evenness	10	1 - 8	19.76	871	1,480	0.59
Wageningen Biodiversity	11	1 - 8	10.58	780	780	1.00

MAT is mean annual temperature (℃), MAP is mean annual precipitation (mm yr^{-1}), mean PET is mean evapotranspiration (mm yr^{-1}), and mean water availability is the ratio of MAP to PET (MAP/PET) during the years of each study.

Supplementary Appendix 1. References for trait data used in this study (obtained via TRY or unpublished studies).

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Supplementary Appendix 2. Mean effect sizes among plant species richness, phylogenetic and fast-slow functional diversity, functional and phylogenetic diversity, the community-weighted mean of fast-slow traits, species asynchrony, and mean and standard deviation of aboveground biomass production across 39 experimental grassland studies.

Methods

To estimate correlations among plant species richness, phylogenetic and fast-slow functional diversity, functional and phylogenetic diversity, the community-weighted mean of fast-slow traits, species asynchrony, and mean and standard deviation of aboveground biomass production, Pearson's correlation coefficients and their corresponding sampling variances were calculated for each study. Using the 'metafor' package, mean effect sizes of the relationships among the aforementioned variables were estimated using random effects models and restricted maximum likelihood[18]. The Knapp-Hartung adjustment was used to account for the uncertainty in the estimation of residual heterogeneity when fitting the random effect models[19] .

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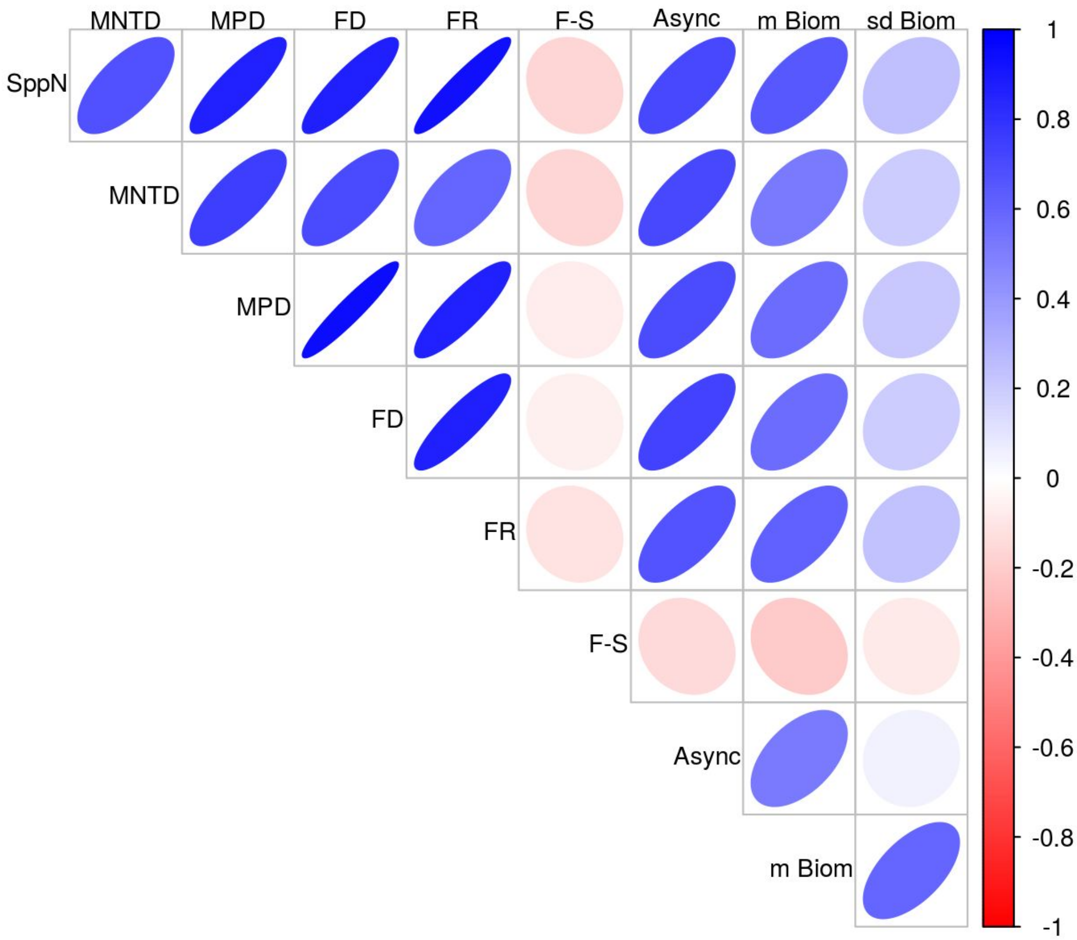

Supplementary Appendix 2 Figure 1. Mean effect sizes among plant species richness, phylogenetic and fast-slow functional diversity, functional and phylogenetic diversity, the community-weighted mean of fast-slow traits, species asynchrony, and mean and standard deviation of aboveground biomass production. SppN is plant species richness, MNTD is abundance-weighted mean nearest taxon phylogenetic distance, MPD is abundance-weighted mean pairwise phylogenetic distance, FD is fast-slow functional diversity calculated using abundance-weighted functional dispersion, FR is fast-slow functional diversity calculated using functional richness, and F-S is the first principal component of the community-weighted mean of fast-slow leaf traits: specific leaf area (SLA), leaf matter dry content (LMDC), and leaf N and P concentrations. Async is species asynchrony, m Biom is mean aboveground biomass production over time, and sd Biom is the standard deviation of aboveground biomass production over time. Effect sizes are Pearson's correlation coefficients and were estimated across studies using mixed-effects models for each unique pair of traits. See Supplementary Appendix 2 Table 1 for mean effect sizes and 95% confidence intervals.

Supplementary Appendix 2 Table 1. Mean effect sizes of pairwise correlations among plant species richness, phylogenetic and fast-slow functional diversity, functional and phylogenetic diversity, the community-weighted mean of fast-slow traits, species asynchrony, and mean and standard deviation of aboveground biomass production across 39 experimental grassland studies.

	SppN	MNTD	MPD	FD	FR	F-S	Async	m Biom
SppN								
MNTD	**0.67**							
MPD	**0.86**	**0.75**						
FD	**0.87**	**0.71**	**0.95**					
FR	**0.94**	**0.60**	**0.86**	**0.87**				
F-S	**-0.16**	**-0.16**	-0.08	-0.06	**-0.11**			
Async	**0.72**	**0.71**	**0.70**	**0.73**	**0.67**	**-0.15**		
m Biom	**0.65**	**0.52**	**0.58**	**0.58**	**0.62**	**-0.20**	**0.52**	
sd Biom	**0.25**	**0.20**	**0.21**	**0.20**	**0.24**	-0.08	0.05	**0.59**

SppN is plant species richness, MNTD is abundance-weighted mean nearest taxon phylogenetic distance, MPD is abundance-weighted mean pairwise phylogenetic distance, FD is abundance-weighted functional dispersion of fast-slow traits, FR is functional richness of fast-slow traits, F-S is the fast-slow spectrum, Asynchrony is species asynchrony, m Biom is mean aboveground biomass production over time, and sd Biom is the standard deviation of aboveground biomass production over time. Values in bold indicate that 95% confidence intervals do not overlap with zero.