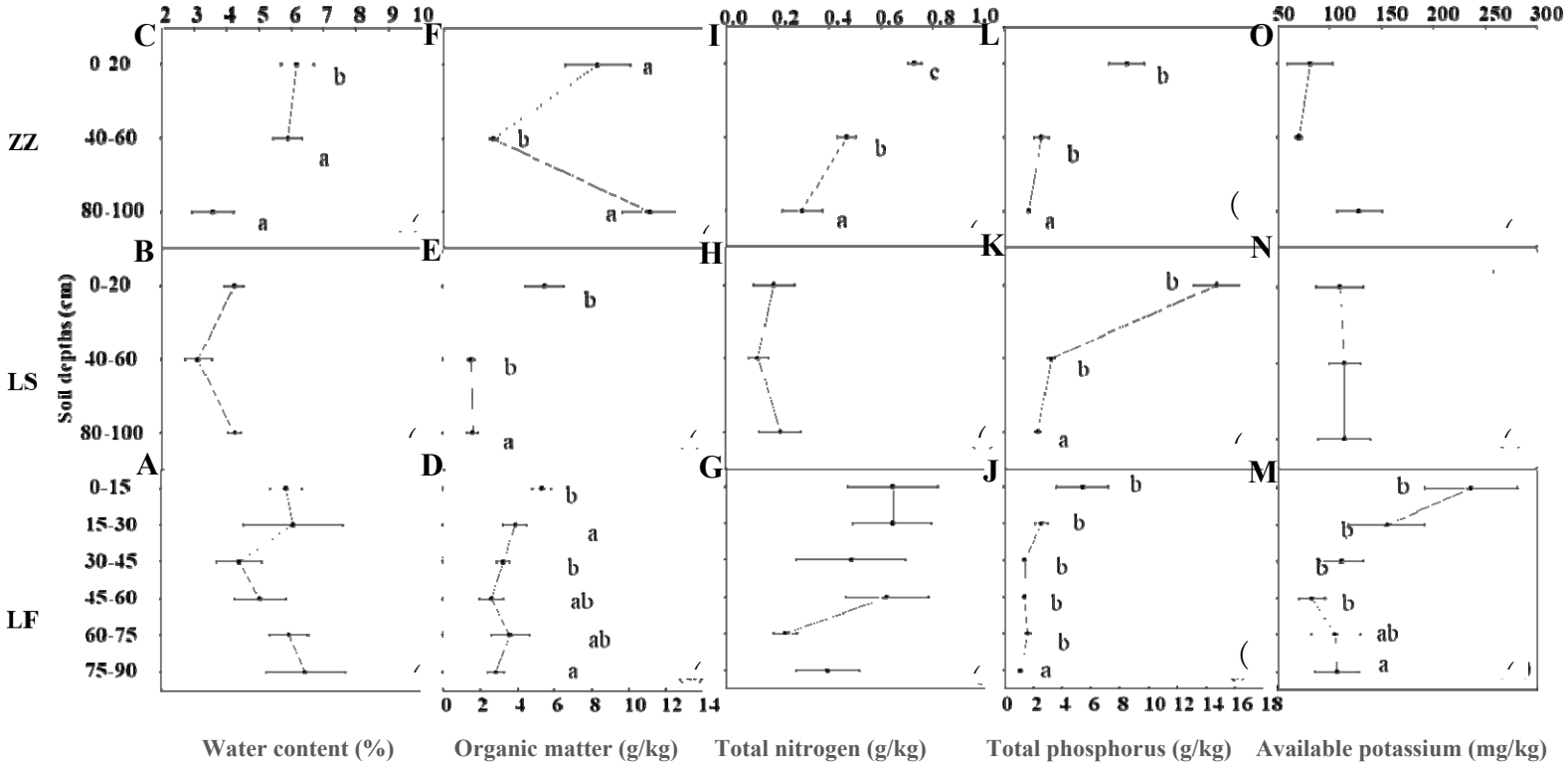

Fig. S1 Changes of physicochemical properties with soil depths across sampling sites. Horizontal coordinate represents the value of the soil properties; Vertical coordinate indicates the depths of soil profiles. The uppercase letters signify the significance of the changes of soil properties across soil profiles. LS, LF and ZZ are the three sampling sites.

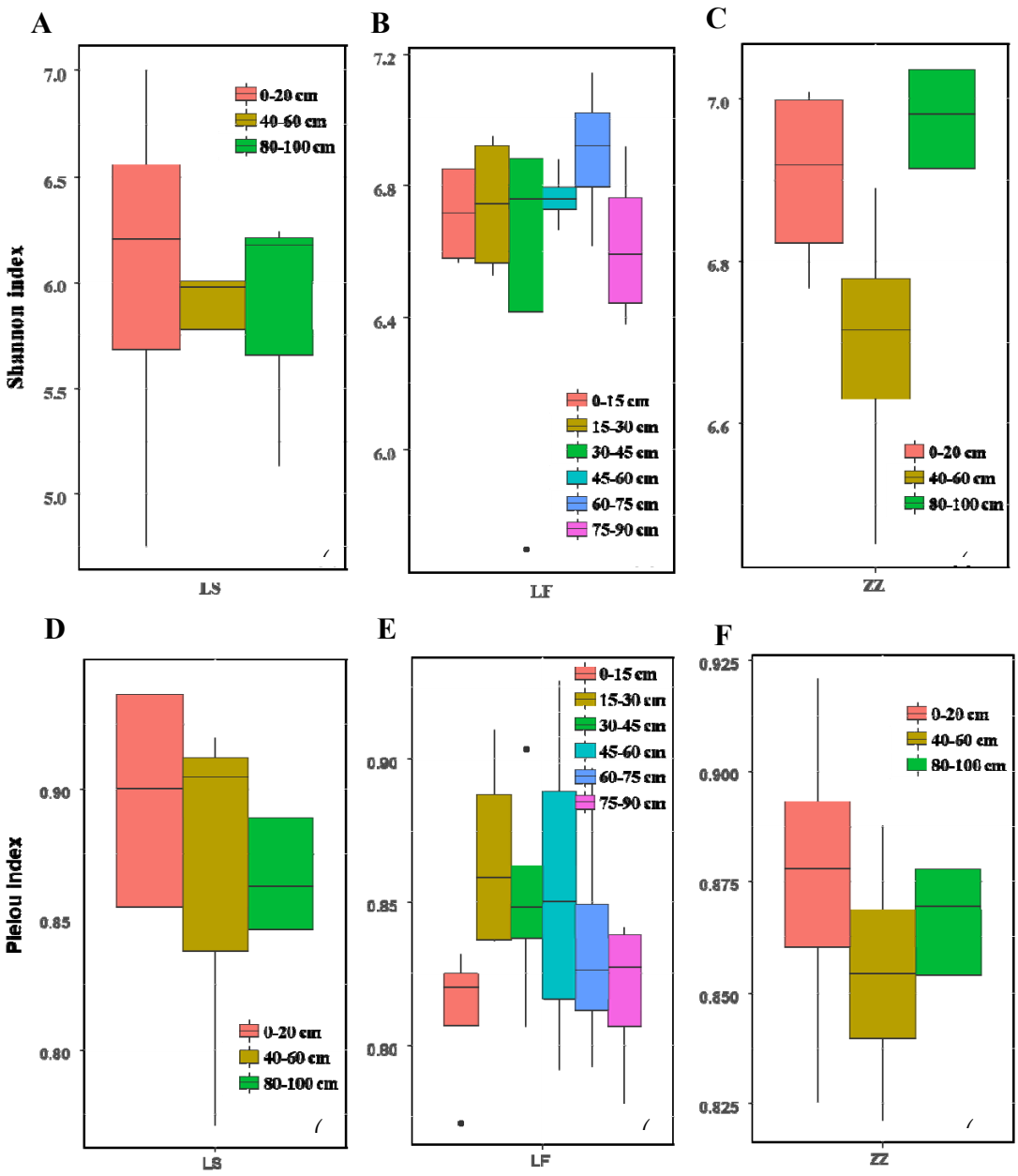

Fig. S2 Changes of microbial alpha diversity (Shannon index: **A-C**; Pielou index: **D-F**) with soil depths from three sampling sites. Different color indicate the depths of soil samples. LF: Langfang city; LS: Lishu county; ZZ: Zhengzhou city.

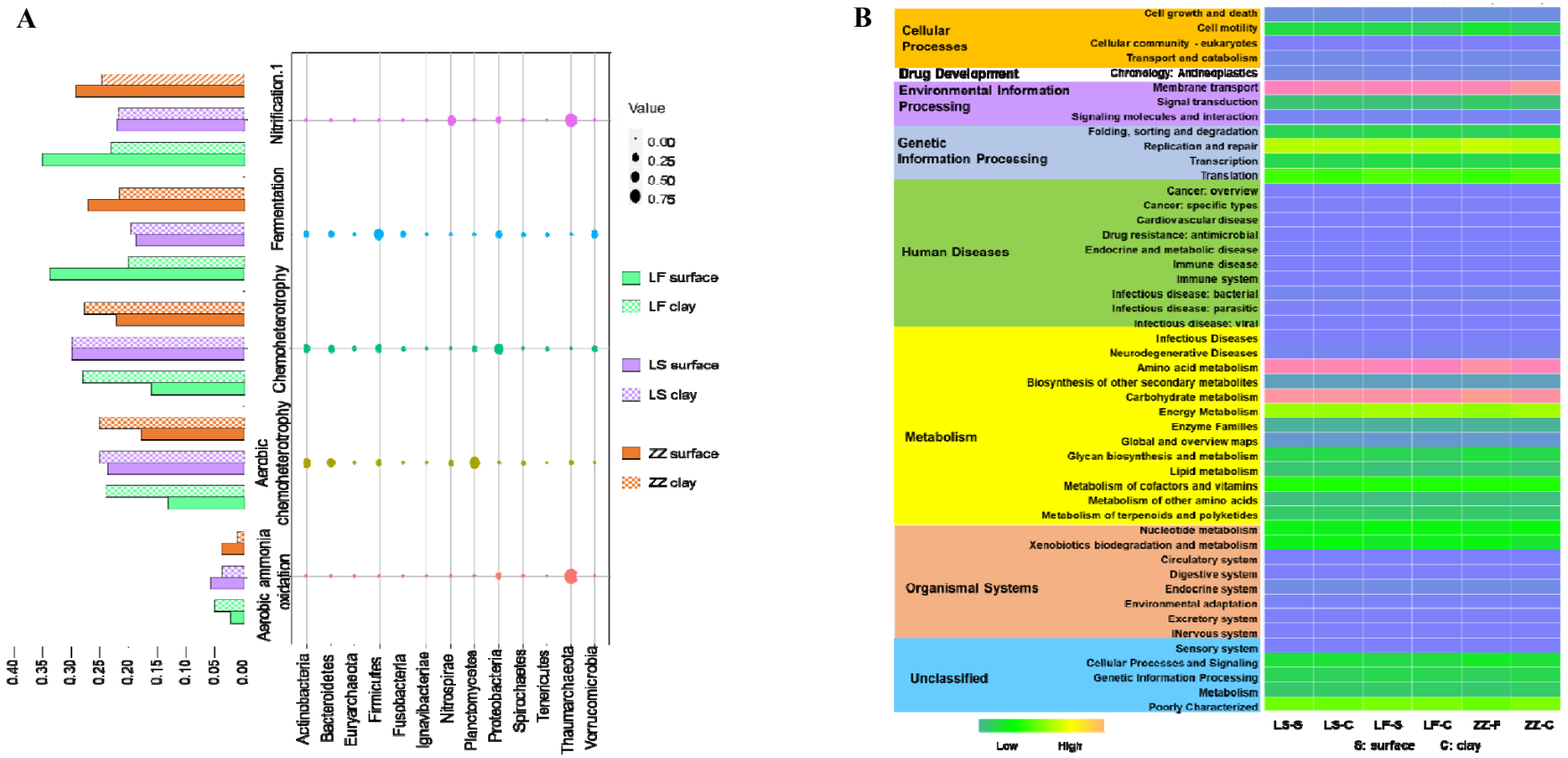

Fig. S3 Function predictions of microbial communities in three sampling sites. **A**: Associations of bacterial phyla with functional groups predicted By FAPROTAX (right) and relative abundance of bacteria participated in consensus functions in three sampling sites (left). **B**: Variations of bacterial function profiles in three sampling sites analyzed by PICRUSt (scaled by function categories).

Table S1 The characteristics of empirical network structure constructed in studies

Network Indexes	LS	LF	ZZ	topsoil	clay layer
Total nodes	108	85	62	84	90
Total links	264	775	968	790	921
R square of power-law	0.777	0.018	0.051	0.07	0.002
Average degree (avgK)	4.889	18.235	31.226	18.81	20.467
Average clustering coefficient (avgCC)	0.269	0.401	0.583	0.374	0.39
Average path distance (GD)	4.022	1.868	1.488	1.812	1.806
Geodesic efficiency (E)	0.313	0.594	0.756	0.607	0.609
Harmonic geodesic distance (HD)	3.193	1.683	1.323	1.648	1.642
Maximal degree	17	32	43	32	35
Nodes with max degree	OTU_14620	OTU_3; OTU_4; OTU_12	OTU_9 OTU_144	OTU_11292	OTU_6
Centralization of degree (CD)	0.115	0.168	0.199	0.163	0.167
Maximal betweenness	695.838	128.429	29.111	88.79	93.433
Nodes with max betweenness	OTU_14620	OTU_952	OTU_144	OTU_99	OTU_6
Centralization of betweenness (CB)	0.098	0.027	0.008	0.016	0.015
Maximal stress centrality	4065	718	396	561	754
Nodes with max stress centrality	OTU_14620	OTU_952	OTU_144	OTU_47	OTU_6
Centralization of stress centrality (CS)	0.594	0.131	0.109	0.099	0.125
Maximal eigenvector centrality	0.3	0.2	0.177	0.201	0.191
Nodes with max eigenvector centrality	OTU_31	OTU_3	OTU_9	OTU_11292	OTU_6
Centralization of eigenvector	0.246	0.106	0.055	0.1	0.092

centrality (CE)					
Density (D)	0.046	0.217	0.512	0.227	0.23
Reciprocity	1	1	1	1	1
Transitivity (Trans)	0.366	0.418	0.598	0.377	0.39
Connectedness (Con)	0.91	1	1	1	1
Efficiency	0.959	0.792	0.496	0.783	0.779
Hierarchy	0	0	0	0	0
Lubness	1	1	1	1	1