

**Fig. S1.** Principal coordinate analysis (PCoA) of soil archaeal community in surface (A), middle (B) and deep (C) soil layer among seasons; principal coordinate analysis (PCoA) of soil bacterial community in surface (D), middle (E) and deep (F) soil layer among seasons.



**Fig. S2.** Random forest mean predictor importance of PCo1 of rare bacterial community (Bac\_rare\_PCo1), PCo1 of abundant bacterial community (Bac\_abundant\_PCo1), PCo1 of rare archaeal community (Arc\_rare\_PCo1), PCo1 of abundant archaeal community (Arc\_abundant\_PCo1), rare bacterial richness (Bac\_rare\_S), abundant bacterial richness (Bac\_abundant\_S), rare archaeal richness (Arc\_rare\_S), abundant archaeal richness (Arc\_abundant\_S) on soil fertility index (A) and functional diversity (B). Significance level: *P* < 0.05, \*; *P* < 0.01, \*\*; *P* < 0.01, \*\*\*.



**Fig. S3.** Random forest mean predictor importance of prokaryotic phyla on soil fertility index. Significance level: *P* < 0.05, \*; *P* < 0.01, \*\*; *P* < 0.01, \*\*\*. Abbreviations: TC, total carbon; TN, total nitrogen; DOC, dissolved organic carbon; DON, dissolved organic nitrogen; NO3, nitrate; NH4, ammonium; SM, soil moisture.