**Additional file 1**

**Figure S1** The map of sample site. The N site is located in Hailun, Heilongjiang Province (126°38′E and 47°26′N), the C site is located in Fengqiu, Henan Province (114°24′E and 35°00′N), and the S site is located in Yingtan, Jiangxi Province (116°55′E and 28°15′N).

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**Figure S2** The relationship between clustering similarities and OTU numbers. Each soil sample in the figure was clusted by 95%, 96%, 97%, 97.5%, 98%, 98.5% or 99%, resulting in various OTU numbers. Mollisol soil at the donor N site is designated as N, Mollisol soil transplanted to the C site is designated as NC, and Mollisol soil transplanted to the S site is designated as NS. Similar designation is used for the C site and the S site. An appendix of m is designated for soil from maize crop plots. Three replicates are represented by a, b and c at the end of the sample name.

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**Figure S3** Rarefaction curves showing the number of OTUs for each sample.



**Figure S4** Multiple regression trees showing the relative importance of soil origin (e.g. Mollisol, Inceptisol, Ultisol) and site location (e.g. N, C, S) on (A) fungal communities in bare fallow soils, (B) fungal communities in maize cropped soils, (C) bacterial communities in bare fallow soils, and (D) bacterial communities in maize cropped soils. Multiple regression trees split data into clusters of sites by using a binary split method, with each split minimizing the dissimilarity of sites within clusters. Factors on the highest layer (e.g. N, C, S in the A diagram) are the most important environmental factors to split the data. Under each histogram, n is the number of samples in the cluster (group); the number under each bar graph is the sum of squared errors for the group, with higher error value indicating larger community dissimilarity among samples in the group.



**Figure S5** The proportional Venn diagram of OTU overlaps among transplanted soil, donor soil and surrounding soil in (A) fungal community and (B) bacterial community. Upper triangles indicate transplanted soils, left triangles indicate donor soils, and right triangles indicate destination soils.

A

B

**Figure S6** The relationships between environmental ranges (the breadth of environmental conditions wherein an OTU is present) and bacterial and fungal OTU occupancy (the number of samples wherein an OTU is present). The environmental range is calculated as the average of all environmental variable ranges normalized from 0 to 1.



**Figure S7** Variance partition analysis (VPA) to partition the contributions of environmental variables to (A) fungal community variations and (B) bacterial community variations. Environmental variables are selected according to the results of Mantel tests. They are split into three groups of V1, V2, and V3. V1 is the climate variable group including the annual temperature and annual rainfall, V2 is soil pH, and V3 is the soil nutrient variable group including soil organic matter total nitrogen, total potassium and total phosphorus. *P* value was calculated by Mantel tests.



**Table S1** SIMPER analyses showing the contribution of individual genus (> 1%) to the dissimilarity between microbial communities at pairwise sites

| Fungi | | | | | | Bacteria | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| genus | N vs C | genus | N vs S | genus | C vs S | genus | Molli-sol vs Incepti-sol | genus | Molli-sol vs Ultisol | genus | Incepti-sol vs Ultisol |
| *Chaetomium* | 7.76% | *Phialemonium* | 10.28% | *Phialemonium* | 10.24% | *Spartobacteria genera incertae sedis* | 33.68% | *Spartobacteria genera incertae sedis* | 19.34% | *Gp4* | 10.89% |
| *Podospora* | 5.55% | *Chaetomium* | 6.59% | *Chaetomium* | 6.80% | *Gp4* | 7.41% | *Conexibacter* | 8.90% | *Spartobacteria genera incertae sedis* | 10.80% |
| *Mortierella* | 5.07% | *Podospora* | 5.20% | *Mortierella* | 5.29% | *Gp6* | 4.93% | *Gp6* | 6.71% | *Conexibacter* | 7.51% |
| *Gibberella* | 4.31% | *Aspergillus* | 4.85% | *Aspergillus* | 4.73% | *Sphingomonas* | 4.20% | *Gp4* | 6.60% | *Gp6* | 7.35% |
| *Coniosporium* | 3.94% | *Glomus* | 3.92% | *Gibberella* | 3.63% | *Gemmatimonas* | 2.70% | *Gp1* | 4.89% | *Gp1* | 5.30% |
| *Fusarium* | 3.40% | *Phialosimplex* | 3.10% | *Glomus* | 3.58% | *GpXIII* | 2.25% | *Ktedonobacter* | 3.75% | *Gemmatimonas* | 4.61% |
| *Entrophospora* | 3.39% | *Agaricus* | 3.05% | *Phialosimplex* | 3.05% | *Gp1* | 2.02% | *Gemmatimonas* | 3.44% | *Ktedonobacter* | 3.01% |
| *Thanatephorus* | 3.27% | *Coniosporium* | 2.95% | *Agaricus* | 3.01% | *Lysobacter* | 1.59% | *Sphingosinicella* | 3.21% | *Sphingomonas* | 2.87% |
| *Cladosporium* | 3.02% | *Thanatephorus* | 2.83% | *Coniosporium* | 2.95% | *Terrimonas* | 1.52% | *Subdivision3 genera incertae sedis* | 2.31% | *Sphingosinicella* | 2.83% |
| *Rhodotorula* | 3.01% | *Cladosporium* | 2.61% | *Entrophospora* | 2.74% | *Gp25* | 1.48% | *Oryzihumus* | 1.86% | *GpXIII* | 1.75% |
| *Phialophora* | 2.74% | *Mortierella* | 2.35% | *Rhodotorula* | 2.56% | *Fervidicoccus* | 1.45% | *Lysobacter* | 1.32% | *Gp25* | 1.53% |
| *Colletotrichum* | 2.34% | *Kochiomyces* | 2.26% | *Fusarium* | 2.51% | *Sphingosinicella* | 1.29% | *Sphingomonas* | 1.25% | *Terrimonas* | 1.52% |
| *Mucor* | 2.03% | *Phialophora* | 2.12% | *Colletotrichum* | 2.32% | *Subdivision3 genera incertae sedis* | 1.06% | *Gp3* | 1.06% | *Oryzihumus* | 1.48% |
| *Geomyces* | 1.55% | *Phaeosphaeria* | 2.10% | *Kochiomyces* | 2.23% |  |  | *GpXIII* | 1.06% | *Fervidicoccus* | 1.22% |
| *Humicola* | 1.51% | *Bipolaris* | 1.64% | *Phaeosphaeria* | 2.01% |  |  |  |  | *Subdivision3 genera incertae sedis* | 1.19% |
| *Clitocybe* | 1.51% | *Geomyces* | 1.45% | *Bipolaris* | 1.93% |  |  |  |  |  |  |
| *Thielaviopsis* | 1.50% | *Cryptococcus* | 1.42% | *Cladosporium* | 1.60% |  |  |  |  |  |  |
| *Verticillium* | 1.40% | *Entrophospora* | 1.36% | *Mucor* | 1.54% |  |  |  |  |  |  |
| *Exophiala* | 1.36% | *Fusarium* | 1.34% | *Cryptococcus* | 1.41% |  |  |  |  |  |  |
| *Articulospora* | 1.30% | *Humicola* | 1.31% | *Pseudogymnoascus* | 1.34% |  |  |  |  |  |  |
| *Penicillium* | 1.30% | *Thielaviopsis* | 1.29% | *Podospora* | 1.29% |  |  |  |  |  |  |
| *Pseudogymnoascus* | 1.29% | *Verticillium* | 1.24% | *Penicillium* | 1.18% |  |  |  |  |  |  |
| *Pyrenochaeta* | 1.26% | *Pyrenochaeta* | 1.23% | *Phialophora* | 1.05% |  |  |  |  |  |  |
| *Alternaria* | 1.18% | *Clitocybe* | 1.20% | *Ochroconis* | 1.05% |  |  |  |  |  |  |
| *Leptosphaerulina* | 1.17% | *Exophiala* | 1.05% |  |  |  |  |  |  |  |  |
| *Bipolaris* | 1.17% |  |  |  |  |  |  |  |  |  |  |
| *Ochroconis* | 1.11% |  |  |  |  |  |  |  |  |  |  |
| *Phialemonium* | 1.08% |  |  |  |  |  |  |  |  |  |  |
| *Phoma* | 1.06% |  |  |  |  |  |  |  |  |  |  |
| *Kochiomyces* | 1.02% |  |  |  |  |  |  |  |  |  |  |

**Table S2** Raw data of environmental variables

| Environmental variable | Annual T (°C) | Annual R (mm) | Soil pH | SOM (g/kg) | WHC (%) | Density (g/cm3) | Soil porosity (%) | EC (μs/cm) | CEC (cmol/kg) | TN (g/kg) | TP (g/kg) | TK (g/kg) | AP (mg/kg) | AK (mg/kg) | NH4-N (mg/kg) | NO3-N (mg/kg) | Seed Weight (kg/ha) | Above-ground Bio-mass (kg/ha) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Na | 2.07 | 496.1 | 6.08 | 45.78 | 48.88 | 1.11 | 56.35 | 19.40 | 33.96 | 1.88 | 0.80 | 18.70 | 40.90 | 185.0 | 0.39 | 17.23 |  |  |
| Nb | 2.07 | 496.1 | 6.28 | 47.26 | 48.88 | 1.11 | 56.35 | 23.00 | 35.74 | 2.00 | 0.81 | 18.63 | 42.52 | 247.5 | 1.09 | 16.15 |  |  |
| Nc | 2.07 | 496.1 | 6.38 | 46.13 | 48.88 | 1.11 | 56.35 | 25.60 | 33.26 | 1.49 | 0.77 | 18.75 | 35.28 | 172.5 | 0.25 | 6.52 |  |  |
| NCa | 13.49 | 832.8 | 6.37 | 43.45 | 45.81 | 1.11 | 57.09 | 63.50 | 8.42 | 1.94 | 0.84 | 18.76 | 39.35 | 167.5 | 0.80 | 3.89 |  |  |
| NCb | 13.49 | 832.8 | 6.35 | 46.33 | 45.81 | 1.11 | 57.09 | 70.10 | 8.32 | 2.23 | 0.84 | 20.11 | 38.39 | 155.0 | 0.67 | 2.80 |  |  |
| NCc | 13.49 | 832.8 | 6.27 | 41.75 | 45.81 | 1.11 | 57.09 | 63.60 | 8.02 | 1.90 | 0.86 | 19.33 | 60.05 | 182.5 | 0.44 | 3.67 |  |  |
| NSa | 18.09 | 1495 | 5.46 | 41.67 | 36.79 | 1.26 | 47.88 | 34.50 | 34.55 | 1.63 | 0.78 | 19.13 | 34.25 | 165.0 | 1.65 | 4.84 |  |  |
| NSb | 18.09 | 1495 | 5.55 | 41.48 | 36.79 | 1.26 | 47.88 | 10.30 | 34.25 | 1.71 | 0.82 | 18.63 | 33.06 | 165.0 | 1.55 | 5.02 |  |  |
| NSc | 18.09 | 1495 | 5.65 | 40.87 | 36.79 | 1.26 | 47.88 | 32.40 | 34.35 | 1.65 | 0.80 | 19.17 | 34.25 | 162.5 | 1.33 | 4.44 |  |  |
| Ca | 13.49 | 832.8 | 7.78 | 9.20 | 25.27 | 1.49 | 45.03 | 38.50 | 12.16 | 0.57 | 0.67 | 17.46 | 7.22 | 97.50 | 0.76 | 3.78 |  |  |
| Cb | 13.49 | 832.8 | 7.86 | 8.40 | 25.27 | 1.49 | 45.03 | 25.70 | 11.26 | 0.58 | 0.65 | 19.53 | 7.60 | 107.5 | 0.81 | 3.22 |  |  |
| Cc | 13.49 | 832.8 | 8.05 | 8.55 | 25.27 | 1.49 | 45.03 | 35.20 | 11.96 | 0.54 | 0.88 | 24.83 | 7.10 | 92.50 | 0.24 | 6.30 |  |  |
| CSa | 18.09 | 1495 | 8.09 | 8.74 | 20.72 | 1.54 | 36.52 | 74.80 | 8.04 | 0.41 | 0.58 | 18.13 | 9.28 | 77.50 | 1.19 | 4.24 |  |  |
| CSb | 18.09 | 1495 | 8.05 | 7.62 | 20.72 | 1.54 | 36.52 | 77.60 | 8.54 | 0.40 | 0.54 | 17.30 | 7.73 | 62.50 | 1.38 | 4.25 |  |  |
| CSc | 18.09 | 1495 | 8.00 | 7.43 | 20.72 | 1.54 | 36.52 | 75.10 | 8.34 | 0.68 | 0.64 | 19.52 | 9.06 | 75.00 | 1.11 | 3.89 |  |  |
| CNa | 2.07 | 496.1 | 7.76 | 9.93 | 31.22 | 1.43 | 43.84 | 43.70 | 34.57 | 0.58 | 0.55 | 17.18 | 5.25 | 117.5 | 0.32 | 3.88 |  |  |
| CNb | 2.07 | 496.1 | 7.93 | 10.13 | 31.22 | 1.43 | 43.84 | 44.90 | 34.87 | 0.70 | 0.59 | 17.19 | 12.23 | 147.5 | 0.41 | 6.05 |  |  |
| CNc | 2.07 | 496.1 | 7.91 | 8.41 | 31.22 | 1.43 | 43.84 | 43.40 | 34.97 | 0.50 | 0.60 | 16.53 | 8.75 | 122.5 | 0.97 | 13.99 |  |  |
| Sa | 18.09 | 1495 | 5.36 | 9.94 | 27.92 | 1.38 | 43.15 | 25.90 | 12.38 | 0.60 | 0.44 | 9.42 | 17.49 | 110.0 | 1.53 | 5.36 |  |  |
| Sb | 18.09 | 1495 | 5.28 | 9.87 | 27.92 | 1.38 | 43.15 | 28.70 | 12.77 | 0.52 | 0.45 | 9.48 | 17.83 | 107.5 | 2.32 | 5.54 |  |  |
| Sc | 18.09 | 1495 | 5.20 | 9.67 | 27.92 | 1.38 | 43.15 | 25.40 | 11.88 | 0.61 | 0.44 | 10.30 | 16.49 | 110.0 | 1.49 | 4.97 |  |  |
| SCa | 13.49 | 832.8 | 5.90 | 10.17 | 32.84 | 1.27 | 52.09 | 25.50 | 12.28 | 0.62 | 0.47 | 10.31 | 24.07 | 232.5 | 1.31 | 4.60 |  |  |
| SCb | 13.49 | 832.8 | 5.71 | 10.21 | 32.84 | 1.27 | 52.09 | 21.80 | 12.77 | 0.93 | 0.46 | 10.73 | 21.75 | 205.0 | 1.08 | 2.73 |  |  |
| SCc | 13.49 | 832.8 | 5.65 | 10.44 | 32.84 | 1.27 | 52.09 | 21.90 | 11.88 | 0.44 | 0.43 | 10.12 | 19.65 | 187.5 | 1.53 | 3.47 |  |  |
| SNa | 2.07 | 496.1 | 7.67 | 9.29 | 35.74 | 1.36 | 46.67 | 58.20 | 9.41 | 0.56 | 0.31 | 9.48 | 13.01 | 195.0 | 0.89 | 0.37 |  |  |
| SNb | 2.07 | 496.1 | 6.36 | 8.97 | 35.74 | 1.36 | 46.67 | 63.30 | 9.31 | 0.55 | 0.33 | 10.08 | 14.32 | 200.0 | 0.87 | 1.03 |  |  |
| SNc | 2.07 | 496.1 | 5.73 | 10.50 | 35.74 | 1.36 | 46.67 | 64.80 | 9.11 | 0.57 | 0.31 | 9.77 | 11.47 | 212.5 | 0.98 | 0.64 |  |  |
| Nma | 2.07 | 496.1 | 6.18 | 52.64 | 64.98 | 0.91 | 64.39 | 53.90 | 34.47 | 2.12 | 0.83 | 18.31 | 32.35 | 142.5 | 0.56 | 7.54 | 3922 | 4500 |
| Nmb | 2.07 | 496.1 | 6.09 | 50.17 | 70.91 | 0.88 | 65.49 | 56.70 | 33.87 | 2.31 | 0.80 | 18.98 | 26.93 | 142.5 | 0.59 | 17.72 | 1597 | 4929 |
| Nmc | 2.07 | 496.1 | 6.12 | 51.40 | 77.82 | 0.86 | 66.20 | 45.40 | 35.18 | 2.24 | 0.79 | 17.89 | 21.12 | 132.5 | 0.72 | 6.43 | 1218 | 5038 |
| NCma | 13.49 | 832.8 | 6.66 | 46.52 | 48.95 | 1.06 | 58.59 | 86.00 | 7.54 | 1.90 | 0.77 | 18.31 | 26.71 | 127.5 | 1.09 | 8.08 | 6987 | 5959 |
| NCmb | 13.49 | 832.8 | 6.62 | 47.46 | 46.10 | 1.09 | 57.79 | 100.0 | 8.74 | 1.94 | 0.79 | 18.68 | 31.40 | 140.0 | 2.06 | 14.75 | 6172 | 5709 |
| NCmc | 13.49 | 832.8 | 6.69 | 51.11 | 49.92 | 1.06 | 58.99 | 105.2 | 7.84 | 1.95 | 0.77 | 18.36 | 26.79 | 127.5 | 0.80 | 6.73 | 6282 | 5815 |
| NSma | 18.09 | 1495 | 5.70 | 42.57 | 39.11 | 1.17 | 54.21 | 70.90 | 12.77 | 1.75 | 0.74 | 18.77 | 20.37 | 132.5 | 1.52 | 11.04 | 1841 | 4761 |
| NSmb | 18.09 | 1495 | 5.75 | 52.38 | 43.28 | 1.14 | 55.61 | 46.30 | 13.07 | 1.85 | 0.80 | 0.00 | 23.80 | 130.0 | 1.39 | 18.64 | 1291 | 4880 |
| NSmc | 18.09 | 1495 | 5.81 | 40.27 | 41.88 | 1.14 | 54.90 | 54.20 | 12.67 | 1.76 | 0.75 | 18.40 | 17.49 | 122.5 | 1.57 | 8.22 | 1210 | 4880 |
| Cma | 13.49 | 832.8 | 8.11 | 8.20 | 27.43 | 1.42 | 47.61 | 65.70 | 34.97 | 0.59 | 0.58 | 17.88 | 3.09 | 75.00 | 0.67 | 3.56 | 5101 | 4143 |
| Cmb | 13.49 | 832.8 | 8.24 | 8.88 | 25.10 | 1.47 | 45.98 | 75.90 | 34.07 | 0.53 | 0.60 | 17.12 | 3.79 | 72.50 | 0.93 | 4.25 | 5549 | 5980 |
| Cmc | 13.49 | 832.8 | 8.08 | 7.87 | 27.00 | 1.39 | 49.23 | 58.30 | 34.07 | 0.48 | 0.57 | 17.50 | 3.49 | 72.50 | 0.74 | 4.64 | 5369 | 5573 |
| CSma | 18.09 | 1495 | 7.60 | 7.30 | 27.84 | 1.33 | 46.25 | 52.60 | 35.18 | 0.52 | 0.63 | 17.85 | 5.84 | 77.50 | 0.93 | 3.87 | 1136 | 4166 |
| CSmb | 18.09 | 1495 | 7.85 | 8.01 | 27.49 | 1.32 | 45.76 | 43.80 | 34.17 | 0.52 | 0.62 | 17.63 | 6.24 | 75.00 | 4.50 | 9.83 | 1150 | 4761 |
| CSmc | 18.09 | 1495 | 7.87 | 8.48 | 30.92 | 1.29 | 45.90 | 53.80 | 34.97 | 0.54 | 0.62 | 17.63 | 5.52 | 72.50 | 1.12 | 5.17 | 922 | 4642 |
| CNma | 2.07 | 496.1 | 8.36 | 11.30 | 49.23 | 1.11 | 56.51 | 77.60 | 8.54 | 0.61 | 0.57 | 17.17 | 5.80 | 75.00 | 0.46 | 4.43 | 1535 | 3383 |
| CNmb | 2.07 | 496.1 | 8.38 | 9.91 | 41.13 | 1.22 | 52.04 | 67.20 | 8.14 | 0.55 | 0.54 | 17.39 | 5.17 | 80.00 | 0.36 | 1.96 | 1903 | 3568 |
| CNmc | 2.07 | 496.1 | 8.36 | 9.68 | 41.50 | 1.22 | 52.00 | 83.00 | 8.34 | 0.56 | 0.59 | 17.68 | 4.82 | 87.50 | 0.56 | 7.47 | 1427 | 2431 |
| Sma | 18.09 | 1495 | 4.96 | 9.12 | 37.29 | 1.17 | 51.81 | 37.30 | 11.58 | 0.61 | 0.42 | 9.65 | 14.32 | 105.0 | 1.54 | 5.54 | 0.00 | 2559 |
| Smb | 18.09 | 1495 | 5.06 | 9.73 | 43.83 | 1.06 | 56.42 | 38.80 | 12.38 | 0.62 | 0.45 | 9.36 | 19.11 | 115.0 | 1.67 | 4.85 | 0.00 | 2380 |
| Smc | 18.09 | 1495 | 5.10 | 9.95 | 35.28 | 1.22 | 49.62 | 36.60 | 12.08 | 1.26 | 0.44 | 10.06 | 18.46 | 110.0 | 1.66 | 5.33 | 0.00 | 2380 |
| SCma | 13.49 | 832.8 | 6.95 | 10.19 | 36.86 | 1.24 | 54.58 | 91.50 | 7.74 | 0.57 | 0.44 | 9.83 | 16.38 | 87.50 | 1.36 | 3.88 | 3724 | 4877 |
| SCmb | 13.49 | 832.8 | 6.88 | 10.19 | 39.78 | 1.18 | 56.33 | 94.30 | 8.14 | 0.57 | 0.42 | 9.71 | 18.00 | 105.0 | 0.86 | 3.29 | 3857 | 3933 |
| SCmc | 13.49 | 832.8 | 6.92 | 10.61 | 35.64 | 1.30 | 51.88 | 98.70 | 8.14 | 0.63 | 0.43 | 9.70 | 19.17 | 127.5 | 0.67 | 3.46 | 3621 | 4252 |
| SNma | 2.07 | 496.1 | 5.25 | 6.07 | 50.43 | 1.04 | 59.41 | 36.30 | 11.26 | 0.65 | 0.41 | 9.63 | 28.15 | 177.5 | 0.80 | 2.02 | 88.69 | 1589.88 |
| SNmb | 2.07 | 496.1 | 5.28 | 10.26 | 52.31 | 1.04 | 59.29 | 42.30 | 11.16 | 0.80 | 0.42 | 9.55 | 24.84 | 165.0 | 0.87 | 3.46 | 106.0 | 2029 |
| SNmc | 2.07 | 496.1 | 5.42 | 10.40 | 48.41 | 1.16 | 54.47 | 40.40 | 10.35 | 0.57 | 0.34 | 9.44 | 18.93 | 142.5 | 1.09 | 1.91 | 306.5 | 2263 |

Abbreviation: Annual T – annual average temperature, Annual R – annual rainfall, SOM – soil organic matter, WHC – water-holding capacity, SD – soil bulk density, EC – electrical conductivity, CEC – cation exchange capacity, TN – total nitrogen, TP – total phosphorus, TK – total potassium, AP – available phosphorus, AK - available potassium.

Mollisol soil at the donor N site is designated as N, and transplanted Mollisol soils to the C site and the S site are designated as NC and NS, respectively. Similar designation is used for the Inceptisol (the C site) and Ultisol soils (the S site). An appendix of m is designated for soil cropped with maize. An appendix of a, b. or c is designated for replicates.