

**Table S1.** The correspondence of the reclassification of the land use and cover changes.

| Raster value | Label  | Reclassify    |
|--------------|--|---------------|
| 0            | no data  | No-data       |
| 10           | cropland, rainfed  | Cropland      |
| 11           | herbaceous cover   | Cropland      |
| 12           | tree or shrub cover  | Cropland      |
| 20           | cropland, irrigated or post-flooding   | Cropland      |
| 30           | mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover <50%) | Mosaic area   |
| 40           | mosaic natural vegetation (trees, shrub, herbaceous cover >50% / cropland <50%)  | Mosaic area   |
| 50           | tree cover, broadleaved, evergreen, closed to open (>15%)                        | Forest        |
| 60           | tree cover, broadleaved, deciduous, closed to open (>15%)                        | Forest        |
| 61           | tree cover, broadleaved, deciduous, closed (>40%)                                | Forest        |
| 62           | tree cover, broadleaved, deciduous, open (15-40%)                                | Forest        |
| 70           | tree cover, needle leaved, even green, closed to open (>15%)                     | Forest        |
| 71           | tree cover, needle leaved, even green, closed (>40%)                             | Forest        |
| 72           | tree cover, needle leaved, even green, open (15-40%)                             | Forest        |
| 80           | tree cover, needle leaved, deciduous, closed to open (>15%)                      | Forest        |
| 81           | tree cover, needle leaved, deciduous, closed (>40%)                              | Forest        |
| 82           | tree cover, needle leaved, deciduous, open (15-40%)                              | Forest        |
| 90           | tree cover, mixed leaf type (broadleaved and needle leaved)                      | Forest        |
| 100          | mosaic tree and shrub (>50%)/ herbaceous cover (<50%)                            | Mosaic area   |
| 110          | mosaic herbaceous cover (>50%)/ tree and shrub (<50%)                            | Mosaic area   |
| 120          | shrubland  | Forest        |
| 121          | evergreen shrubland  | Forest        |
| 122          | deciduous shrub land   | Forest        |
| 130          | grassland  | Grassland     |
| 140          | lichens and mosses   | Bare area     |
| 150          | sparse vegetation (tree, shrub, herbaceous cover) (<15%)                         | Forest        |
| 152          | sparse shrub (<15%)  | Forest        |
| 153          | sparse herbaceous cover (<15%)   | Forest        |
| 160          | tree cover, flooded, fresh or brackish water                                     | Forest        |
| 170          | tree cover, flooded, saline water  | Forest        |
| 180          | shrub or herbaceous cover, flooded, fresh / saline / brackish water              | Forest        |
| 190          | urban areas  | Built-up area |
| 200          | bare areas   | Bare area     |
| 201          | consolidated bare areas  | Bare area     |
| 202          | unconsolidated bare areas  | Bare area     |
| 210          | water bodies   | Water area    |
| 220          | permanent snow and ice   | Water area    |

**Table S2.** The area of suitable habitats (before and after optimization) of apple trees on the Loess Plateau ( $10^4 \times \text{km}^2$ ). The CUH represents the class unsuitable habitat.

| Periods and<br>climate scenarios | Unsuitable habitat |       | Low suitable habitat |       | Moderate suitable habitat |       | High suitable habitat |       | CUH   |
|----------------------------------|--------------------|-------|----------------------|-------|---------------------------|-------|-----------------------|-------|-------|
|                                  | Before             | After | Before               | After | Before                    | After | Before                | After |       |
| 2050SSP1-26                      | 41.80              | 31.22 | 15.24                | 9.04  | 7.43                      | 4.03  | 0.42                  | 0.17  | 20.42 |
| 2030SSP1-26                      | 40.31              | 31.56 | 18.38                | 11.10 | 6.12                      | 3.07  | 0.08                  | 0.03  | 19.12 |
| 1970-2000                        | 43.78              | 36.15 | 12.31                | 7.66  | 7.94                      | 2.80  | 0.85                  | 0.23  | 18.05 |
| 2030SSP5-85                      | 36.70              | 28.05 | 18.02                | 11.84 | 9.78                      | 5.67  | 0.39                  | 0.18  | 19.15 |
| 2050SSP5-85                      | 37.23              | 26.15 | 16.51                | 10.78 | 10.43                     | 7.06  | 0.71                  | 0.46  | 20.43 |