Supplementary Data

Table S1. Summary of the characteristics of agricultural payments for ecosystem services case in China and study area (Mengyin County).

Table S1.1 Main characteristics of agricultural payments for ecosystem services case in China

Program/Policy	Start year	Who initiated?	Targeted ecosystem services	Reference
Rural biogas development	2001-2005[a]	Central government	Fermentation for organic waste, water protection	[1]
Promoting conservation tillage	2002[b]	Central government	Soil protection, reducing soil erosion	[2,3]
Agricultural support protection subsidies (The"three subsidies"policy)	2004[c]	Central government	Food, soil protection	[4]
Soil testing and fertilizer recommendation	2005[d]	Central government	Soil protection, decreasing external inputs	[5]
Organic fertilizer subsidy	2004[e]	Municipal government (Shanghai)	Soil protection, improving soil fertility	[6,7]
Safe pesticides subsidy	2009[f]	Municipal government (Beijing)	Soil and water protection, using low or non-toxic pesticides	[8,9]
Fish cultivation in rice fields	2007-2009[g]	Dali prefecture government (Dali City)	Biological weed and pest control	[10]
Incentive mechanism for paddy field conservation	2013-2015[h]	Municipal government (Suzhou)	Soil and water quality protection, preventing paddy fields from turning into non-agriculturalization areas	[11]

Table S1.2 Main characteristics of agricultural payments for ecosystem services case in study area

Program/Policy	Start year (Mengyin County)	Mode of payment	Payment amount, cash equivalent (Mengyin County)	Restricted conditionality
Rural biogas development	2003[i]	Cash	800-1000 Yuan/ biogas pool (8-10 m^3)	Overburdened local

				farmers and high administration costs
Agricultural support protection subsidies (The“three subsidies”policy)	2004[i]	Cash + in-kind	1875 Yuan/ ha/yr (2016)	Monitoring costs; risk of reducing other incentives
Soil testing and fertilizer recommendation	2005-2007[i]	Technical assistance + free information	Total cash equivalent 350,000 Yuan/yr (2015); in fact lower or highly variable	Funding and information availability, knowledge of land use-soil testing information links

[a] China’s 10th Five-Year Plan (2001-2005) calls for promoting rural renewable energy technologies and rural biogas development. Rural biogas development has been creatively developed with the southern “pig-biogas-fruit” (a combination of pig husbandry with biogas and fruit tree planting) and the northern “pig-biogas-vegetable-greenhouse” (a combination of pig husbandry with biogas, vegetable planting and sunlight greenhouse building) as typical models.

[b] In 2002, the Chinese government was actively involved in the demonstration and extension of conservation tillage practices. Since 2002, the Chinese Ministry of Agriculture has formulated a plan to promote a widespread application of conservation tillage throughout the dryland regions of northern China.

[c] Beginning in 2004, agriculture taxes were eliminated and subsidies in the form of cash, high-quality grain seeds, and machinery (The“three subsidies”policy) have been made to households to stimulate grain production and increase farmer income. Most of cash and grain seed subsidies are non-distorting and account for the majority of agricultural subsidies in the 2000s, but machinery subsidy is based on farmers’ actual purchase of machineries and are still far less than other two. In 2016, three subsidies have merged into agricultural support protection subsidies.

[d] In 2005, the No. 1 document from the national central government clearly regarded "soil testing and fertilizer recommendation" as one of the largest domestic technologies across the country. The technology of soil testing and fertilizer recommendation can not only decrease costs and increase the benefits of agriculture but also reduce agricultural non-point source pollution and greenhouse gas emissions.

[e] In 2004, the municipality of Shanghai which has established incentives or pilot programs aimed at enhancing organic waste utilization and reducing pollution. The subsidy contributed to the straw recycling and the use of green manure and organic fertilizers.

[f] In 2009, the municipality of Beijing proposed a series of subsidy policies to lead farmers to apply proper pesticide and scientific farming. Based on a non-contact IC card and a precision management system, agricultural-related subsidies are managed.

[g] Based on the Erhai catchment project in Yunnan, with the compensation object being farmers in the watershed, the Dali Prefecture government tested methods of funding compensation, technical compensation and intellectual compensation from 2007 to 2009.

[h] From 2013 to 2015, the municipal government of Suzhou defined the general land use planning and identified protected fields by the land and agricultural administrative sectors.

[i] Document database (2003-2016) from agricultural administrative sectors and finance bureau of Mengyin County.

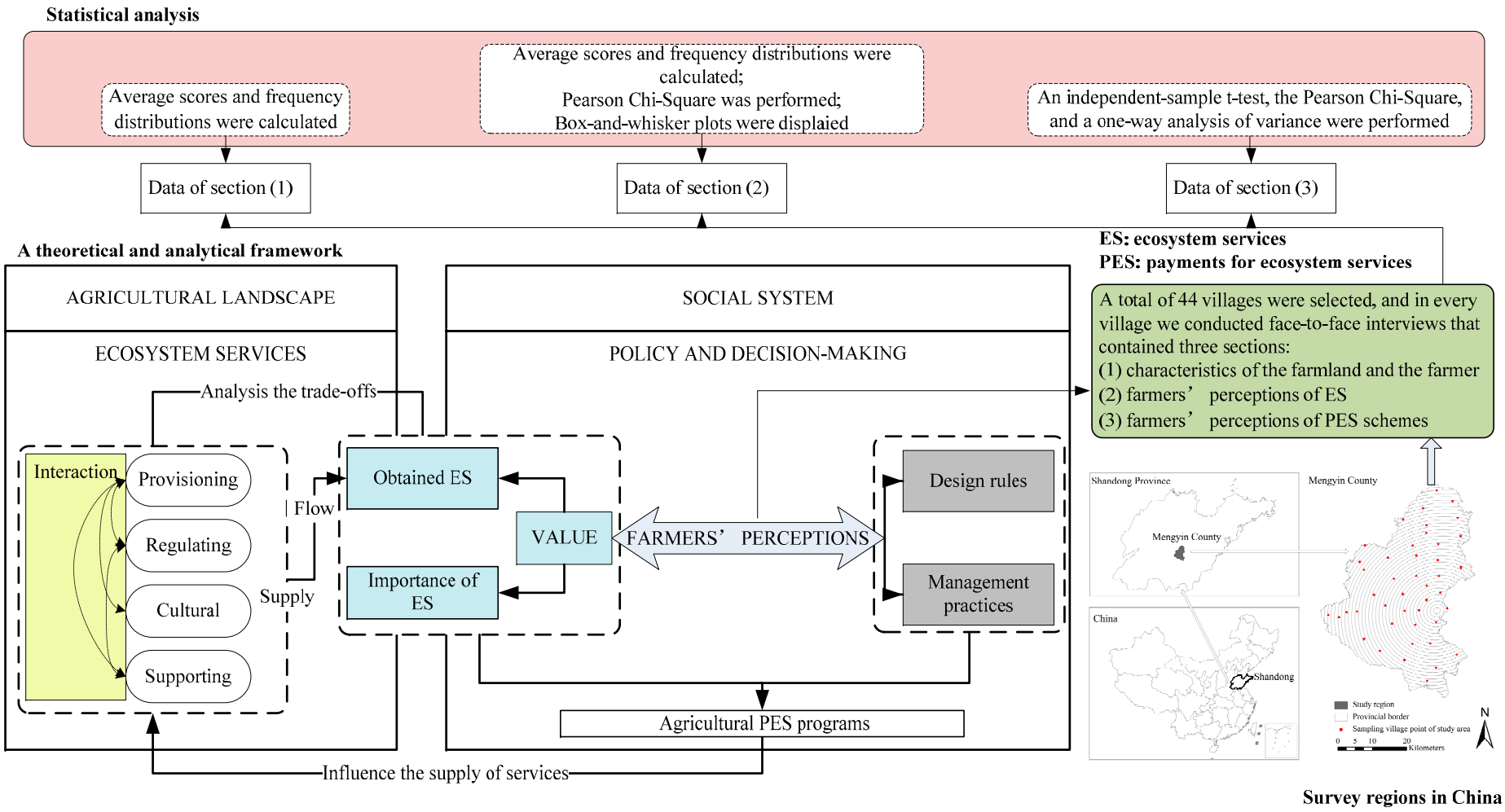
Statistical analysis
Average scores and frequency distributions were calculated
Average scores and frequency distributions were calculated;
Pearson Chi-Square was performed;
Box-and-whisker plots were displaied
An independent-sample t-test, the Pearson Chi-Square, and a one-way analysis of variance were performed
Data of section (1)
Data of section (2)
Data of section (3)
A theoretical and analytical framework
ES: ecosystem services
PES: payments for ecosystem services
AGRICULTURAL LANDSCAPE
SOCIAL SYSTEM
ECOSYSTEM SERVICES
POLICY AND DECISION-MAKING
A total of 44 villages were selected, and in every village we conducted face-to-face interviews that contained three sections:
(1) characteristics of the farmland and the farmer
(2) farmers' perceptions of ES
(3) farmers' perceptions of PES schemes
Analysis the trade-offs
Interaction
Provisioning
Regulating
Cultural
Supporting
Supply
Flow
Obtained ES
VALUE
Importance of ES
FARMERS' PERCEPTIONS
Design rules
Management practices
Agricultural PES programs
Influence the supply of services
Shandong Province
Mengyin County
China
Shandong
Mengyin County
Study region
Provincial border
Sampling village point of study area
0 5 10 20
Kilometers
N
Survey regions in China

Figure S1. Graphic abstract. A list of 17 ecosystem services was used in this study, including 4 provisioning services (Food, Raw materials, Medicinal resources, Ornamental resources); 7 regulating services (Water purification, Water regulation, Maintaining healthy waterways and reservoirs, Waste assimilation, Natural hazard regulation, Pollination, Biological pest control); 3 cultural services (Recreation and aesthetic values, Cultural heritage values, Discriminating features and sense of place); 3 supporting services (Maintenance of soil fertility and health, Maintenance of natural genetic diversity, Maintenance of semi-natural habitat). A list of 14 management measures was used in this study, including 7 off-field practices (Hedgerow management, Grassland management, Riparian strips vegetation management, Field margins vegetation management, Ecologically sound for the management of forest land, Flower and protection strips on riparian , Flower and protection strips on field margins) and 7 on-field practices (Crop rotation, Intercropping , Protection for wild plants on fields, Application of mulch and direct sowing, Maintenance of orchard mulching, Flower strips on crop land, Organic farming).

Table S2. Summary of published studies on the ecosystem structure, processes, function and services of the 14 selected management measures.

Management measures		Ecosystem services	Ecosystem structure, processes and function	Reference
Off-field practices	Hedgerow management	Maintenance of semi-natural habitat Recreation and aesthetic values	Hedgerows are a key semi-natural habitat for biodiversity, act as a corridor of movement and dispersal for many species, and respond to the aesthetic wishes of the local population.	[12,13]
	Grassland management	Maintenance of soil fertility and health Water regulation	Grassland management could enhance the plant-soil cycle with the function of the soil structure and water regulations under grassland conditions.	[14,15]
	Riparian strips vegetation management	Natural hazard regulation Water purification	Riparian vegetative buffer strips can be used to intercept surface runoff flow, nutrient and other organic pollutants before they enter the stream and can improve the water quality and reduce the flood risk.	[16,17]
	Field margins vegetation management	Maintenance of semi-natural habitat Biological pest control	Field margins are linear semi-natural structures, are important for many flora and fauna, and provide habitat functions for natural enemies of crop herbivores.	[18,19]
	Ecologically sound for the management of forest land	Maintenance of the semi-natural habitat Water regulation	Ecologically sound stewardship has long been a cornerstone of the forestry profession. By connecting the lower atmosphere with deep ground water, they regulate regional climate, speed up soil development, with roots injecting organic matter into the ground, and produce habitat structures that provide food and shelter for myriad organisms, including humans.	[20]
	Flower and protection strips on riparian	Maintenance of natural genetic diversity Pollination	Sowing flower and protection strips on riparian can enhance habitat heterogeneity and ecological connectivity to promote insect pollinators and drive pollinator diversity in intensively managed landscapes.	[21]
	Flower and protection strips on field margins	Recreation and aesthetic values Pollination	Sowing flower and protection strips on field margins, such as adding early-season nectar-producing plants, can improve pollination and the aesthetic value of the landscape.	[22,23]

Table S2. Continued.

Management measures		Ecosystem services	Ecosystem structure, processes and function	Reference
On-field practices	Crop rotation	Maintenance of soil fertility and health Biological pest control	Increasing crop diversity through rotation aims to restore positive above ground–below ground interactions and use biotic interactions to reduce chemical inputs. High diversity rotations can sustain soil biological communities, with positive effects on soil organic matter and soil fertility.	[24,25]
	Intercropping	Maintenance of soil fertility and health Biological pest control	Intercropping increases plant diversity in cropping systems and has the potential to increase soil physical stability and control weeds, pests and diseases compared to sole cropping.	[26,27]
	Protection for wild plants on fields	Maintenance of natural genetic diversity Biological pest control	Wild plants are a promising source of traits that could enable plants to withstand insect attack and other stressful conditions, and they harbor a reservoir of genetic traits. Setting aside some farmland as wildlife habitat may not reduce crop yields with less input of harmful chemicals.	[28,29]
	Application of mulch and direct sowing	Biological pest control Water regulation	Direct seeding mulch-based cropping has the potential to increase soil water tension, thus reducing water stress risks for the crop, and it favors natural enemies, thus disfavoring pests.	[30]
	Maintenance of orchard mulching	Maintenance of soil fertility and health Water regulation	Orchard mulching application significantly alters the soil bacterial community structure and function, benefits the development of soil quality, and improves the soil water-holding capacity.	[31]
	Flower strips on crop land	Biological pest control Pollination	Sowing flower strips on crop land can provide forage for a range of pollinating species, offering undisturbed habitats for natural enemy populations.	[32]
	Organic farming	Maintenance of soil fertility and health Biological pest control	Increasing both the total extent of organic farming and the connectivity of individual farms can restore parasitoid diversity and enhance soil health.	[33,34]

Note: Each management measure only summarizes two individual services that were listed in this study and were reported by published studies on that ecosystem structure, processes and function giving rise to the biophysical supply of ecosystem services.

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