

## **Supplementary materials**

# **Willingness and technology preference of farmers and their influencing factors for soil remediation**

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## S1 Survey area

Table S1 Survey areas.

Coden ame	Location	Climate zones	Contamina tions	Causes	Phytore mediati on (mu)	Passivati on (mu)	Numbe r of samples	Note
A	Longmen Village, Xiying Township, Luancheng District, Shijiazhuang City, Hebei Province	Temperate continental monsoon climate zone	Arsenic, cadmium	Sewage irrigation	100	300	98	No significant impact on human health and crop yield
B	Wuxing Village, Banqiao Town, Mianzhu City, Deyang, Sichuan Province	Humid subtropical climate zone	Chromium , arsenic, cadmium	Phosphogyps um slag site	500	500	147	No significant impact on human health and crop yield
C	Heshan Village, Baiyun Township, Shimen County, Changde City, Hunan Province	Monsoon climate zone	Arsenic	Realgar mining and arsenic smelting	959	1017	190	Serious harm to local human health
D	Sidi Village, Xingping Town, Yangshuo County, Guilin City, Guangxi Province	Central subtropical monsoon climate zone	Cadmium, lead, arsenic	Lead-zinc tailings sand dam collapses	75	212	118	Severe impact on crop growth

## **S2 Survey questionnaire**

Farmers in four soil remediation project areas in China where both phytoremediation and passivation remediation were conducted were targeted to conduct a household questionnaire survey using random sampling and a one-to-one structured interview method. Specifically, the researcher asked the farmers questions and filled out a questionnaire based on their responses.

The main content of the questionnaire consisted of five parts: basic information about the farmers interviewed (such as gender, age, education), household and production characteristics (including family size, farmland area, income composition), current status of participation in soil remediation (such as farmland area remediated, labor income), satisfaction with current remediation and willingness to remediate in the future, preference for remediation technology, and impact of technical characteristics. The content of the questionnaire relevant to this study is as follows.

### **A Basic information of the farmers interviewed**

A01 Name

A02 Gender\_\_\_\_\_ (1=man, 0=woman)

A03 Age\_\_\_\_\_ (one full year of life)

A04 Education\_\_\_\_\_ ( Number of years in school)

A05 Environmental protection awareness\_\_\_\_\_ (1 = very weak; 2 = relatively weak;  
3 = normal; 4 = relatively strong; 5 = very strong)

## B Household and production characteristics

B01 There are \_\_\_\_\_ people in the family and \_\_\_\_\_ people working in agriculture.

B02 How much mu of farmland do your family have? \_\_\_\_\_ mu.

B03 How much mu of farmland currently produce crops? \_\_\_\_\_ mu.

B04 Input and output of farmland.

Variable name	Unit	Crop 1 _____		Crop 2 _____		Crop 3 _____	
Sown area	Mu						
Single yield	kg/mu						
Unit price	yuan/kg						
Seeds	yuan						
Fertilizers	yuan						
Herbicides	yuan						
Plowing	yuan						
Sowing	yuan						
Harvesting	yuan						
Transporting	yuan						
Total farm income	yuan /mu						

B05 Household income (except income from participation in soil remediation projects).

Variable name	Self-employed industrial and commercial income	Income from working outside	Income from working locally	Soil rent subsidy	Breeding income	Transfer income (from children or relatives)	Government subsidy	Total income
Before project implementation								

After project implementation								
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### C Current status of participation in soil remediation

C01 Does your family have farmland to carry out soil remediation projects?

\_\_\_\_\_ (1=yes; 2=no)

C02 Participate in passivation

C02-1 A total of \_\_\_\_\_ mu for passivation with subsidies of \_\_\_\_\_ per mu.

C02-2 Income from employment related to participation in passivation \_\_\_\_\_.

Variable name	Unit	Crop 1_____	Crop 2_____	Crop 3_____
Labor unit price	yuan/manday			
Sown area	mu			
Plowing and seeding	manday			
Fertilizer application	manday			
Herbicide injection	manday			
Other passivation employment	manday			

C02-3 Crop income from farmland of passivation \_\_\_\_\_

Variable name	Unit	Crop 1_____	Crop 2_____	Crop 3_____
Cost	yuan/mu			
Area	mu			
Unit yield	kg/mu			
Unit price	yuan/kg			

C03 Participate in phytoremediation

C03-1 A total of \_\_\_\_\_ mu for phytoremediation with subsidies of \_\_\_\_\_ per

mu.

C03-2 Income from employment related to participation in phytoremediation

\_\_\_\_\_.

Variable name	Unit	Hyperaccumulator
Labor unit price	yuan/manday	
Area	mu	
Transplanting	manday	
Activator application	manday	
Fertilizer application	manday	
Weed control	manday	
Mowing	manday	
Other phytoremediation employment	yuan	

#### **D Satisfaction with current remediation and willingness to remediate in the future**

The following scores are set as 1: strongly disagree; 2: relatively disagree; 3: not sure; 4: relatively agree; 5: strongly agree

D01 Soil remediation is carried out without affecting household food supply.\_\_\_\_\_

D02 Subsidies for farmland involved in soil remediation can compensate for losses. \_\_\_\_\_

D03 Participation in soil remediation has increased family income. \_\_\_\_\_

D04 You are satisfied with the current state of the remediation. \_\_\_\_\_

D05 You will continue to support contaminated soil remediation projects. \_\_\_\_\_

D06 You are willing to transfer all your farmland for soil remediation. \_\_\_\_\_

D07 Did you think about petitioning before the remediation project started because of pollution issues?\_\_\_\_\_ (yes/no) Do you still want to petition now?\_\_\_\_\_ ( yes/no)

### **E Remediation technology preferences and technical characteristics impact**

E01 Do you think the agricultural soils need remediation in the current situation?\_\_\_\_\_ (1=yes; 2=no)

E02 If yes, which remediation technology do you prefer?\_\_\_\_\_ (1=phytoremediation; 2=passivation)

E03 What factors do you value in a remediation technology and please rate the factors that influence your choice of technology characteristics (1: strongly disagree; 2: relatively disagree; 3: not sure; 4: relatively agree; 5: strongly agree)

- 1 Remediation period\_\_\_\_\_
- 2 Economic income\_\_\_\_\_
- 3 Soil quality\_\_\_\_\_
- 4 Risk of secondary contamination \_\_\_\_\_
- 5 Other factors\_\_\_\_\_

E04 Why do you think soil remediation is not needed?\_\_\_\_\_

### **S3 Descriptive statistics of sample farmers**

Table S2 Descriptive statistics of sample farmers.

Indicator	Category	Frequency	Proportion (%)	Option	Frequency	Proportion (%)
Gender	man	342	61.9	non-participation	23	6.7

Indicator	Category	Frequency	Proportion (%)	Option	Frequency	Proportion (%)
	woman	211	38.1	phytoremediation	272	79.5
				passivation	47	13.7
				non-participation	3	1.4
				phytoremediation	186	88.2
				passivation	22	10.4
				non-participation	0	0.0
Age	<40	17	3.1	phytoremediation	14	82.4
				passivation	3	17.6
				non-participation	6	7.6
	[40, 50)	79	14.3	phytoremediation	67	84.8
				passivation	6	7.6
				non-participation	12	6.6
	[50, 60)	181	32.7	phytoremediation	147	81.2
				passivation	22	12.2
				non-participation	7	3.5
	[60, 70)	199	36.0	phytoremediation	169	84.9
				passivation	23	11.6
				non-participation	1	1.3
	≥70	77	13.9	phytoremediation	61	79.2
				passivation	15	19.5
				non-participation	2	1.6
Education	Illiterate	122	22.1	phytoremediation	106	86.9
				passivation	14	11.5
				non-participation	12	5.3
	Primary school	228	41.2	phytoremediation	186	81.6
				passivation	30	13.2
				non-participation	9	5.8
	Junior high school	156	28.2	phytoremediation	126	80.8
				passivation	21	13.5
				non-participation	3	6.7
	High school	45	8.1	phytoremediation	38	84.4
				passivation	4	8.9
				non-participation	0	0.0
	College and above	2	0.4	phytoremediation	2	100.0
				passivation	0	0.0
				non-participation	2	5.7
Family size	1	35	6.3	phytoremediation	27	77.1
				passivation	6	17.1
				non-participation	6	3.6
	2	166	30.0	phytoremediation	135	81.3
				passivation	25	15.1
				non-participation	16	7.8
	3-4	204	36.9	phytoremediation	170	83.3
				passivation	18	8.8
				non-participation	1	0.8
	5-6	126	22.8	phytoremediation	108	85.7
				passivation	17	13.5
				non-participation	1	4.5
	≥ 7	22	4.0	phytoremediation	18	81.8
				passivation	0	0.0



Indicator	Category	Frequency	Proportion (%)	Option	Frequency	Proportion (%)
Agricultural labor	0	14	2.6	passivation	3	13.6
				non-participation	1	7.1
				phytoremediation	12	85.7
	1	87	15.7	passivation	1	7.1
				non-participation	4	4.6
				phytoremediation	76	87.4
	2	292	52.8	passivation	7	8.0
				non-participation	20	6.8
				phytoremediation	236	80.8
	3-4	117	21.1	passivation	36	12.3
				non-participation	0	0.0
				phytoremediation	98	83.8
	$\geq 5$	43	7.8	passivation	19	16.2
				non-participation	1	2.3
				phytoremediation	36	83.7
Annual income (yuan)	<5000	91	16.5	passivation	6	14.0
				non-participation	9	9.9
				phytoremediation	71	78.0
	[5000, 15000)	189	34.2	passivation	11	12.1
				non-participation	8	4.2
				phytoremediation	157	83.1
	[15000, 25000)	103	18.6	passivation	24	12.7
				non-participation	5	4.9
				phytoremediation	85	82.5
	[25000, 35000)	77	13.9	passivation	13	12.6
				non-participation	2	2.6
				phytoremediation	64	83.1
	$\geq 35000$	93	16.8	passivation	11	14.3
				non-participation	2	2.2
				phytoremediation	81	87.1
				passivation	10	10.8
Farmland area (mu)	<2	91	16.4	non-participation	9	9.9
				phytoremediation	71	78.0
				passivation	11	12.1
	[2, 4)	189	34.1	non-participation	8	4.2
				phytoremediation	157	83.1
				passivation	24	12.7
	[4, 6)	103	18.7	non-participation	5	4.9
				phytoremediation	85	82.5
				passivation	13	12.6
	[6, 8)	77	14	non-participation	2	2.6
				phytoremediation	64	83.1
				passivation	11	14.3
	$\geq 8$	93	16.8	non-participation	2	2.2
				phytoremediation	81	87.1
				passivation	10	10.8
Farm income (yuan/y)	$\leq 0$	320	57.9	non-participation	13	4.1
				phytoremediation	274	85.6
				passivation	33	10.3
	(0, 1000]	58	10.5	non-participation	11	19.0
				phytoremediation	44	75.9
				passivation	3	5.2

Indicator	Category	Frequency	Proportion (%)	Option	Frequency	Proportion (%)
Non-farm income (yuan/y)	(1000, 2500]	42	7.6	non-participation	1	2.4
				phytoremediation	35	83.3
				passivation	6	14.3
	(2500, 4000]	30	5.4	non-participation	0	0.0
				phytoremediation	25	83.3
				passivation	5	16.7
	>4000	103	18.7	non-participation	1	1.0
				phytoremediation	80	77.7
				passivation	22	21.4
	0	59	10.7	non-participation	3	5.1
				phytoremediation	49	83.1
				passivation	7	11.9
	(0, 5000]	153	27.7	non-participation	7	4.6
				phytoremediation	132	86.3
				passivation	14	9.2
Project income (yuan/y)	(5000, 15000]	135	24.4	non-participation	9	6.7
				phytoremediation	107	79.3
				passivation	19	14.1
	(15000, 25000]	91	16.5	non-participation	4	4.4
				phytoremediation	74	81.3
				passivation	13	14.3
	>25000	115	20.8	non-participation	3	2.6
				phytoremediation	96	83.5
				passivation	16	13.9
	0	134	24.2	non-participation	10	7.5
				phytoremediation	101	75.4
				passivation	23	17.2
	(0, 1000)	119	21.6	non-participation	12	10.1
				phytoremediation	94	79.0
				passivation	13	10.9
	[1000, 4000)	145	26.2	non-participation	3	2.1
				phytoremediation	119	82.1
				passivation	23	15.9
	[4000, 7000)	74	13.4	non-participation	1	1.4
				phytoremediation	64	86.5
				passivation	9	12.2
	$\geq 7000$	81	14.7	non-participation	0	0.0
				phytoremediation	80	98.8
				passivation	1	1.2

## S4 SEM

Table S3 Variable description and data statistics of the SEM.

Latent variable	Observable variable	Assign a value	Mean	Standard deviation
Individual characteristics	IC1 Age	Assignment of 1-5	3.43	1.00
	IC2 Education	based on survey data	2.24	0.90

		according to a 5-point scale		
	IC3 Environmental protection awareness	1: very weak; 2: relatively weak; 3: normal; 4: relatively strong; 5: very strong	4.26	1.20
Household endowments	HE1 Agricultural labor	Assignment of 1-5 based on survey data	2.35	0.69
	HE2 Farmland		2.64	1.15
	HE3 Income	according to a 5-point scale	2.80	1.33
	HE4 Non-farm income		3.09	1.30
Technical characteristics	TC1 I value the remediation period	1: strongly disagree; 2: relatively disagree; 3: not sure; 4: relatively agree; 5: strongly agree	4.18	0.97
	TC2 I value the impact of remediation on soil quality		3.37	1.24
	TC3 I value the secondary pollution from remediation technology		2.93	1.42
Participation status	PS1 Farmland areas for remediation	Assignment of 1-5 based on survey data	2.75	1.55
	PS2 Project labor income	according to a 5-point scale	2.21	1.37
Perceived benefits	PB1 Remediation does not affect food supply	1: strongly disagree; 2: relatively disagree; 3: not sure; 4: relatively agree; 5: strongly agree	4.49	0.87
	PB2 Subsidies for participation in remediation can cover losses		3.55	1.40
	PB3 Participating in remediation can improve income		3.86	1.34
Farmers' willingness	FW1 Satisfied with the current status of remediation	1: strongly disagree; 2: relatively disagree; 3: not sure; 4: relatively agree; 5: strongly agree	4.34	1.16
	FW2 Willing to continue to support remediation		4.71	0.80
	FW3 Willing to remediate all farmland		4.52	0.94

Table S4 Latent variable reliability test.

Latent variable	Cronbach $\alpha$
Individual characteristics	0.872
Household endowments	0.887
Technical characteristics	0.885
Participation status	0.863
Perceived benefits	0.811
Farmers' willingness	0.788

Table S5 KMO and Bartlett's test.

KMO	Bartlett's sphericity test		
	Approximate chi-square	Degree of freedom	Significance
0.924	6291.605	153	0.000

Table S6 Model structure validity (model fitness).

Indicator name	Value	Critical value
Chi-square	373.539	The smaller the better
Chi/DF	3.037	1-3
GFI	0.918	> 0.9
AGFI	0.886	> 0.9
RMSEA	0.065	< 0.08

## S5 Random forest

Table S7 Random forest variable descriptions and data statistics.

Dependent variable		Variable type	Option 1	Number	Option 2	Number
Technology preference		Classification	Phytoremediation	458	Passivation	69
Independent variable		Variable type	Mean	SD	Mean	SD
Individual Farmer Characteristics	Gender	Classification (man=1; woman=2)	1.41	0.49	1.32	0.47
	Age	Continuous	58.6	9.6	60.4	10.7
	Education	Classification level (1-5)	2.22	0.91	2.22	0.84
Household endowments	Family size	Continuous	3.50	1.65	3.42	1.92
	Agricultural labor	Continuous	2.38	1.30	2.59	1.41
	Farmland (mu)	Continuous	4.12	2.36	3.90	2.30
	Income (yuan)	Continuous	21928.2	24539.0	20097.4	17954.2
	Farm income (yuan)	Continuous	1715.3	3822.5	3264.7	4954.8
	Non-farm income (yuan)	Continuous	15807.8	22915.3	16315.2	18635.7
Participation status	Participation in technology	Classification (non=0; pas=1; phy=2; both=3)	1.06	0.89	0.87	0.86
	Project income (yuan)	Continuous	2360.8	4345.0	634.5	1468.5
	Income difference before and after remediation (yuan)	Continuous	2158.3	6980.6	367.4	4321.0
Technical characteristics	Soil quality	Classification level (1-5)	3.57	1.21	2.49	1.04
	Secondary pollution	Classification level (1-5)	3.17	1.38	1.55	0.83
	Remediation period	Classification level (1-5)	4.11	0.96	4.62	0.97

## S6 Principal component analysis

Table S8 KMO and Bartlett's test (phytoremediation).

KMO	Bartlett's sphericity test		
	Approximate chi-square	Degree of freedom	Significance
0.537	1068.550	55	0.000

Table S9 Total variance explanation of PCA (phytoremediation).

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	2.420	21.999	21.999	2.420	21.999	21.999
2	1.606	14.604	36.603	1.606	14.604	36.603
3	1.486	13.509	50.112	1.486	13.509	50.112
4	1.098	9.983	60.095	1.098	9.983	60.095
5	.961	8.738	68.834			
6	.895	8.138	76.971			
7	.846	7.688	84.659			
8	.606	5.510	90.169			
9	.478	4.349	94.518			
10	.445	4.041	98.559			
11	.158	1.441	100.000			

Extraction method: principal component analysis.

Table S10 KMO and Bartlett's test (passivation).

KMO	Bartlett's sphericity test		
	Approximate chi-square	Degree of freedom	Significance
0.550	149.670	55	0.000

Table S11 Total variance explanation of PCA (passivation).

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	2.608	23.711	23.711	2.608	23.711	23.711
2	1.561	14.188	37.899	1.561	14.188	37.899
3	1.337	12.151	50.051	1.337	12.151	50.051
4	1.264	11.489	61.540	1.264	11.489	61.540
5	1.080	9.817	71.357	1.080	9.817	71.357
6	.899	8.171	79.528			
7	.690	6.273	85.801			

8	.548	4.984	90.784
9	.399	3.631	94.415
10	.328	2.981	97.396
11	.286	2.604	100.000

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Extraction method: principal component analysis.