



**Figure S1.** Realistic map of tobacco fields from Google Earth Pro (109°26'02", 30°41'0") (Left) and field survey (Right). The red arrow represents the slope direction.

**Table S1.** Semi-variogram parameters for soil available phosphorus (AVP) and soil available potassium (AVK) in 2012 and 2021.

Item	Year	Unit	Optimal model	Nugget variance (Co)	Sill variance (Co + C)	Nugget effect (Co/(Co + C))	Range (km)		Anisotropy ratio	Angle Direction of major axis	RSS	R <sup>2</sup>
							Major axis	Minor axis				
AVP	2012	mg/kg	Spherical	33	452.7	7.29	0.53	0.36	0.67	northwest-southeast	0.015	0.35
	2021	mg/kg	Exponential	65	593.6	10.95	1.53	1.19	0.78	northwest-southeast	0.003	0.46
AVK	2012	mg/kg	Exponential	670	5033	13.31	2.19	1.45	0.66	northwest-southeast	0.778	0.66
	2021	mg/kg	Exponential	2410	23340	10.33	1.26	0.84	0.67	northwest-southeast	1.863	0.65

Note: RSS: residual sum of squares (RSS), R<sup>2</sup>: largest coefficient of determination.

**Table S2.** Selected optimal variables for RF model using Boruta algorithm.

Item	Abbreviation	AVP changes	AVK changes
Distance from nearest town center	DFT	√	√
Village density	VD	√	√
Normalized difference vegetation index	NDVI	√	√
Elevation	Ele	√	√
Slope	Slp	√	√
Aspect	Asp	×	√
Plane curvature	PLC	√	√
Profile curvature	PRC	×	×
Topographical wetness index	TWI	√	×
Aggregation index	AI	√	√
Landscape contagion index	CONTAG	×	√
Landscape shape index	LSI	×	×
Patch size	MPS	×	×
Number of covariates		8	9

Note: AVP: soil available phosphorus, AVK: soil available potassium, √: retained, ×: excluded.