Supplementary material for

Potential crop yield gains under intensive soybean/maize intercropping in China

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Part1 References for publications used in the meta-analysis

1. Ahmed A, Aftab S, Hussain S et al (2020) Nutrient accumulation and distribution assessment in response to potassium application under maize-soybean intercropping system. Agronomy 10(5): 725.3.
2. Ahmed S, Rao MR (1982) Performance of maize-soybean intercrop combination in the tropics: results of a multi-location study. Field Crops Research, 5(2): 147-161.
3. Ahmed S, Raza MA, Yuan XQ et al (2020) Optimized planting time and co-growth duration reduce the yield difference between intercropped and sole soybean by enhancing soybean resilience toward size-asymmetric competition. Food and Energy Security 9(3): e266.
4. Bai LS, Fan MP, Wang ZL et al (2019) Relationship between root characteristics and aggregate stability in the field with maize and soybean intercropping. Research of Soil and Water Conversation 26(01): 124-129. (Chinese article with English abstract).
5. Cai Q, Sun ZX, Zheng JM et al (2021) Dry matter accumulation, allocation, yield and productivity of maize soybean intercropping systems in the semi-arid region of western liaoning province. Scientia Agricultura Sinica 54(5): 909-920. (Chinese article with English abstract).
6. Chang HH, Su YB, Fan MP et al (2022) Effects of maize and soybean intercropping on the function and structure of rhizosphere microbial community. Journal of Yunnan Agricultural University (Natural Science) 37(2): 336-343. (Chinese article with English abstract).
7. Chang HH, Su YB, Fan MP et al (2022) Rhizospheric microecological effects of corn and soybean intercropping in sloping farm-land with red soil. Journal of Shanxi Agricultural University (Natural Science Edition) 42(2): 21-28. (Chinese article with English abstract).
8. Chang YM, Zhang ZK, Zhao Y et al (2021) Effects of maize-soybean intercropping on the occurrence of major diseases, insect pests and the yield of maize. Journal of Plant Protection 48(2): 332-339. (Chinese article with English abstract).
9. Chen GP, Wang XC, Pu T et al (2016) Relationship of field microclimate and population yield in maize-soybean relay strip intercropping system. Acta Agriculturae Zhejiangensis 28(11): 1812-1821. (Chinese article with English abstract).
10. Chen L, Zhang CC, Zhang XJ et al (2013) Effects of phosphate fertilizer on intercropping advantage and phosphate fertilizer utilization of different intercropping system. Chinese Agricultural Science Bulletin 29(6): 137-141. (Chinese article with English abstract).
11. Chen P, Du Q, Liu XM et al (2017) Effects of reduced nitrogen inputs on crop yield and nitrogen use efficiency in a long-term maize-soybean relay strip intercropping system. Plos One 12(9): e0184503.
12. Chen P, Song C, Liu XM et al (2019) Yield advantage and nitrogen fate in an additive maize-soybean relay intercropping system. The Science of the Total Environment 657(MAR.20): 987-999.
13. Chen WJ, Liang J, Tang FY et al (2017) Benefit analysis for different spring soybean-maize intercropping patterns in Guangxi. Journal of Southern Agriculture

48(4): 633-639. (Chinese article with English abstract).
14. Chen XQ, Fan MP, Wang ZL et al (2015) Effect of different planting patterns on soil and water conservation of sloping cropland in central Yunnan. Journal of Soil and Water Conservation 29(04): 48-52+65. (Chinese article with English abstract).
15. Chen YK, Feng LY, Muhammad AR et al (2019) Effect of maize/soybean relay strip intercropping system on soybean morphology, chlorophyll fluorescence, and yield in Sichuan area. Chinese Journal of Eco-Agriculture 27(6): 870-879. (Chinese article with English abstract).
16. Cheng B, Liu WG, Wang L et al (2021) Effects of planting density on photosynthetic characteristics, yield and stem lodging resistance of soybean in maize-soybean strip intercropping system. Scientia Agricultura Sinica 54(19): 4084-4096. (Chinese article with English abstract).
17. Cheng B, Wang L, Liu RJ et al (2022) Shade-tolerant soybean reduces yield loss by regulating its canopy structure and stem characteristics in the maize-soybean strip intercropping system. Frontiers in Plant Science 13:848893.
18. Cheng YZ, Li L, Zhou Q et al (2016) Growth and yield formation of maize under different maize/soybean intercropping patterns. Journal of Nanjing Agricultural University 39(1): 34-39. (Chinese article with English abstract).
19. Cui L, Su BY, Yang F et al (2015) Relationship between light interception and light utilization of soybean canopy in relay strip intercropping system. Scientia Agricultura Sinica 48(1): 43-54. (Chinese article with English abstract).
20. Cui L, Yang WY, Huang N et al (2015) Effects of maize plant types on dry matter accumulation characteristics and yield of soybean in maize-soybean intercropping systems. Chinese Journal of Applied Ecology 26(8): 2414-2420. (Chinese article with English abstract).
21. Dai ZL, Wang YT, Yao XY et al (2020) Effects of maize/soybean intercropping on the microbial community characteristics of maize rhizosphere soil, maize yield and diseases. Journal of Yunnan Agricultural University (Natural Science) 35(05): 756-764 (2020). (Chinese article with English abstract).
22. Du Q, Zhou L, Chen P et al (2020) Relay-intercropping soybean with maize maintains soil fertility and increases nitrogen recovery efficiency by reducing nitrogen input. The Crop Journal 8: 140-152.
23. Fan YF, Liu QL, Wang R et al (2017) Effects of shading on growth, photosynthetic fluorescence characteristics and yield of soybean in maize-soybean intercropping systems. Journal of Nuclear Agricultural Sciences 31(5): 972-978. (Chinese article with English abstract).
24. Fan YF, Yang F, He ZZ et al (2016) Effects of shading and light recovery on soybean morphology and photosynthetic characteristics in soybean-maize intercropping system. Chinese Journal of Eco-Agriculture 24(5): 608-617. (Chinese article with English abstract).
25. Fan YW, Xin XL, Zhong XY et al (2021) Effects of intercropping of maize and legume cover crops on enzyme activities and fungal community characteristics in fluvo-aquic soil. Soils 53(6): 1236-1243. (Chinese article with English abstract).
26. Fang P, Liu WG, Zou JL et al (2015) Influence of intercropping on growth, development

and yield formation of vegetable soybean. Soybean Science 34(04): 601-605. (Chinese article with English abstract).
27. Fang XF, Zhang ZLL, Wang LX et al (2017) Effects of different mulching method and planting patterns on soil moisture, temperature and maize yield. Water Saving Irrigation (12): 39-43. (Chinese article with English abstract).
28. Feng L, Huang GQ, Yang WT et al (2021) Yields and interspecific relationship of the maize-soybean intercropping system in the upland red soil of Jiangxi Province. Chinese Journal of Eco-Agriculture 29(7): 1127-1137. (Chinese article with English abstract).
29. Fu ZD, Zhou L, Chen P et al (2019) Effects of maize-soybean relay intercropping on crop nutrient uptake and soil bacterial community. Journal of Integrative Agriculture 18(9): 13.
30. Gao Y, Duan AW, Liu ZG et al (2009) Effect of Intercropping Patterns on dry matter accumulation and yield components of maize and soybean. Chinese Agricultural Science Bulletin 25(02): 214-221. (Chinese article with English abstract).
31. Gao Y, Duan AW, Qiu XQ et al (2010) Distribution of roots and root length density in a maize/soybean strip intercropping system. Agricultural Water Management 98(1): 199-212.
32. He Y, Ding N, Shi JC et al (2013) Profiling of microbial PLFAs: implications for interspecific interactions due to intercropping which increase phosphorus uptake in phosphorus limited acidic soils. Soil Biology & Biochemistry 57: 625-634.
33. Huang JX, Sui P, Gao, WS et al (2017) Effect of maize-soybean intercropping on soil nitrous oxide emissions in silt loam soil of the north china plain. Pedosphere 10.1016/S1002-0160(17): 60389-8.
34. Huang YP, Hai JB, Luo HB et al (2015) Effects of different planting patterns and top dressing levels on photosynthetic characteristics and yield of spring maize. Acta Agriculturae Boreali-occidentalis Sinica 24(09): 43-50. (Chinese article with English abstract).
35. Jin J, Yu CB, Pang J et al (2021) Effects of bandwidth and row ratio on dry matter accumulation and yield of maize/soybean intercropping system in southwest mountain area of Hubei. Chinese Journal of Oil Crop Sciences 43(5): 914-922. (Chinese article with English abstract).
36. Jiu JJ, Li YM, Wang MX et al (2021) Effects of maize and soybean intercropping on aggregate distribution and stability of red soil in sloping land. Journal of Jianhsu Agriculture Sciences 49(22): 219-228. (Chinese article with English abstract).
37. Li LK, Zou Y, Wang YH et al (2022) Effects of corn intercropping with soybean/peanut/millet on the biomass and yield of corn under fertilizer reduction. Agriculture 12(2): 151.
38. Li LK, Zuo CB, Yu FL et al (2019) Effects of monoculture and intercropping of maize and soybean with reduced use of fertilizer on crop yields, insect community composition and diversity. Journal of Plant Protection 46(5): 980-988. (Chinese article with English abstract).
39. Li QS, Li JJ, Ye JH et al (2020) Crop-yields of maize and legume under intercropping cultivation. Fujian Journal of Agricultural Sciences 35(6): 582-590. (Chinese article with English abstract).

40. Li SM, Qiao HT, Lv J (2011) Dynamic changes of dry matter accumulation and yield analysis under the intercropping of soybean and maize. Tianjin Agricultural Sciences 17(4): 38-41. (Chinese article with English abstract).
41. Li SW, Evers JB, Werf W et al (2020) Plant architectural responses in simultaneous maize/soybean strip intercropping do not lead to a yield advantage. Annals of Applied Biology 177(2): 195-210.
42. Li T, Zhang L, Liu DH et al (2021) Effects of native AMF and intercropping reducing nitrogen loss from soil-water interface in purple soil. Acta Pedologica Sinica 58(1): 191-201. (Chinese article with English abstract).
43. Li Z, Qin XY, Li M et al (2011) Comparison on maize agronomic traits and yield of intercropping and monoculture. Maize Science 19(6): 91-94. (Chinese article with English abstract).
44. Li ZX, Wang JW, Yang WT et al (2010) Benefit of sweet corn/soybean intercropping in Guangdong Province. Chinese Journal of Eco-Agriculture 18(3): 627-631. (Chinese article with English abstract).
45. LiI P, Pang CM, Hai T et al (2020) Comparison of yield and benefit of different intercropping modes of maize and soybean in Huanghuai Region. Journal of Hebei Agricultural Sciences 24(4): 14-18. (Chinese article with English abstract).
46. Liu JX, Lu YG, Yuan HW et al (2007) Study on phosphorus being absorbed and utilized under the condition of soybean and maize intercropping. Journal of Mountain Agriculture and biology 26(4): 88-291. (Chinese article with English abstract).
47. Liu P, Shao YT, Wang ZG et al (2019) Effect of nitrogen reduction on yield stability of sweet maize//soybean intercropping system in South China. Chinese Journal of Eco-Agriculture 27(9): 1332-1343. (Chinese article with English abstract).
48. Liu X, Rahman T, Song C et al (2017) Changes in light environment, morphology, growth and yield of soybean in maize-soybean intercropping systems. Field Crops Research 200: 38-46.
49. Liu X, Rahman T, Song C et al (2018) Relationships among light distribution, radiation use efficiency and land equivalent ratio in maize-soybean strip intercropping. Field Crops Research 224: 91-101.
50. Liu Y, Sun ZX, Bai W et al (2011) Effect of maize and soybean interplanting on crops growth and yield in western Liaoning Province. Soybean Science 30(2): 224-228. (Chinese article with English abstract).
51. Liu YK, Yan XD, Xu YP et al (2012) Study on maize and soybean intercropping pattern and economic benefit. Journal of Hebei Agricultural Sciences 16 (3): 23-26. (Chinese article with English abstract).
52. Luo K, Yuan XT, Xie C et al (2022) Diethyl aminoethyl hexanoate increase relay strip intercropping soybean grain by optimizing photosynthesis aera and delaying leaf senescence. Frontiers in Plant Science 12: 818327.
53. Lv JF, Zhang GH, Guo TW et al (2011) Benefit analysis of different soybean intercropping modelsin Semi-arid Area. Soybean Science 30(2): 234-237. (Chinese article with English abstract).
54. Lv Y, Francis C, Wu P et al (2014) Maize-soybean intercropping interactions above and below ground. Crop Science 54(3): 914-922.

55. Ma ZP, Fan XP, Chen XQ et al (2016) Study on root system and red soil anti-erodibility of slope farmland under intercropping of mazie and soybean. Journal of Soil and Water Conservation 30(04): 68-73. DOI:10.13870/j.cnki.stbcxb.2016.04.012. (Chinese article with English abstract).
56. Meng FF, Wang B, Liu BQ et al (2014) Analysis of yield and main agronomic traits of maize in maize and soybean strip intercropping system. Crops (03): 101-105. (Chinese article with English abstract).
57. Ni HW, Zhong SF (1994) Studies on the row ration patterns of intercropping maize and soybean. Acta Agricultural Universitatis Jiangxienis (01): 99-105. (Chinese article with English abstract).
58. Nie HW, Eneji AE, Chen YQ et al (2012) Nitrate leaching from maize intercropping systems with N fertilizer over-dose. Journal of Integrative Agriculture 11(9): 1555-1565.
59. Pan LW, Zhu NN, Yang YL et al (2021) Production pattern of maize-soybean intercropping system under mechanization production condition. Journal of Maize Sciences 29(1): 104-111. (Chinese article with English abstract).
60. Qin WL, Zhang XY, Chen SY (2018) Crop rotation and N application rate affecting the performance of winter wheat under deficit irrigation. Agricultural Water Management 210: 330-339.
61. Rahman T, Liu X, Hussain S et al (2017) Water use efficiency and evapotranspiration in maize-soybean relay strip intercrop systems as affected by planting geometries. Plos One 12(6): e0178332.
62. Raza MA, Feng LY, Werf W et al (2020) Optimum strip width increases dry matter, nutrient accumulation, and seed yield of intercrops under the relay intercropping system. Food and Energy Security 9(2): e199.
63. Ren YY, Liu JJ, Wang ZL et al (2016) Planting density and sowing proportions of maize-soybean intercrops affected competitive interactions and water-use efficiencies on the Loess Plateau, China. European Journal of Agronomy 72: 70-79.
64. Ren YY, Wang ZL, Wang XL et al (2015) The effect and mechanism of intercropping pattern on yield and economic benefit on the Loess Plateau. Acta Ecologica Sinica 35(12): 4168-4177. (Chinese article with English abstract).
65. Ren YY, Zhang L, Yu Y et al (2021) Competitive effect of soybean density on yield formation in maize/soybean intercropping systems. Acta agronomica sinica 47(10): 1978-1987. (Chinese article with English abstract).
66. Shen L, Wang XY, Teng YX et al (2022) Study on the influence of maize‖soybean on crop growth and yield in arid area. Journal of Shihezi University (Natural Science) 40(01): 13-20. (Chinese article with English abstract).
67. Shen LH, Li N, Ruan MH et al (2020) Effects of interactions between roots of intercropped maize and soybean on plant photosynthesis, crop yield, and soil physiochemical properties. Fujian Journal of Agricultural Science 35(11): 1280-1288. (Chinese article with English abstract).
68. Shen YW, Sui P, Huang JX et al (2018) Global warming potential from maize and maize-soybean as affected by nitrogen fertilizer and cropping practices in the north china plain. Field Crops Research 225: 117-127.
69. Song C, Wang QL, Zhang XF et al (2020) Crop productivity and nutrients recovery in

maize-soybean additive relay intercropping systems under subtropical regions in Southwest China. International Journal of Plant Production 14: 373-387.
70. Su BY, Liu X, Cui L et al (2018) Suppression of weeds and increases in food production in higher crop diversity planting arrangements: A case study of relay intercropping. Climate Change 58(4): 1729-1739.
71. Su BY, Song YX, Song C et al (2014) Growth and photosynthetic responses of soybean seedlings to maize shading in relay intercropping system in Southwest China. Photosynthetica 52(3): 332-340.
72. Tang JC, Mboreha IA, She LN et al (2005) Nutritional effects of soybean root architecture in a maize/soybean intercropping system. Scientia Agricultura Sinica 38(6): 1196-1203. (Chinese article with English abstract).
73. Wang F, Xie TS (2015) Comprehensive effects of wide-narrow-band intercropping model of crop in hilly red-soil dryland. Acta Agriculturae Jiangxi 27(12): 11-14. (Chinese article with English abstract).
74. Wang J, Sui B, Wang HB et al (2021) Effects of different corn and soybean intercropping modes on crop yield and water use efficiency in Jilin corn belt. Journal of Jilin Agricultural University 43(1): 22-27. (Chinese article with English abstract).
75. Wang R, Wang HF, Chen XX et al (2012) Light environment characteristics of soybean in maize-soybean intercropping system. Journal of Northeast Agricultural University 43(4): 16-20. (Chinese article with English abstract).
76. Wang RX, Su LZ, Zhang LY, et al (2022) Quantitative mechanism analysis of improving P availability effect in red soil after maize/soybean intercropping. Chinese Journal of Eco-Agriculture 30(7): 1155-1163. (Chinese article with English abstract).
77. Wang T, Wang QX, Li YM et al (2021) Effect of maize and soybean intercropping on root system and soil aggregate stability. Journal of Yunnan Agricultural University (Natural Science) 36(3): 507-515. (Chinese article with English abstract).
78. Wang XC, Wu XL, Ding GH et al (2020) Analysis of grain yield differences among soybean cultivars under maize-soybean intercropping. Agronomy 10(1): 110.
79. Wang XL, Chen Y, Yang KP et al (2021) Effects of legume intercropping and nitrogen input on net greenhouse gas balances, intensity, carbon footprint and crop productivity in sweet maize cropland in south china. Journal of Cleaner Production 314: 127997-.
80. Wang XR, Zhang RZ, Li SM et al (2019) Simulation of dry matter accumulation and nitrogen absorption in a maize/soybean intercropping system supplied with different nitrogen levels. Chinese Journal of Eco-Agriculture 27(9): 1354-1363. (Chinese article with English abstract).
81. Wang XW, Yang WT, Miao JQ et al (2014) Effects of maize-soybean intercropping and nitrogen fertilizer on yield and agronomic traits of maize. Acta Ecologica Sinica 34(18): 5275-5282. (Chinese article with English abstract).
82. Wang ZG, Jin X, Bao XG et al (2014) Intercropping enhances oroductivity and maintains the most soil fertility properties relative to sole cropping. Plos One 9(12): e113984.
83. Wang ZL, Ren YY, Zhang SQ (2014) Effect of maize-soybean intercropping modes on maize growth on Loess Platea. Bulletin of Soil and Water Conservatio 34(06): 321-326. (Chinese article with English abstract).
84. Weng QY, Huang XJ, Xu HL et al (2021) Effects of corn/soybean intercropping model

on yield, quality, soil nutrition and rhizosphere microorganisms of silage corn. Journal of Nuclear Agricultural Sciences 35(2): 462-470. (Chinese article with English abstract).
85. Wu YS, Gong WZ, Yang F et al (2021) Dynamic of recovery growth of intercropped soybean after maize harvest in maize-soybean relay strip intercropping system. Food and Energy Security 11(1): e350.
86. Xia HH, Wang ZG, Zhao JH et al (2013) Contribution of interspecific interactions and phosphorus application to sustainable and productive intercropping systems. Field Crops Research 154: 53-64.
87. Xiao T, Cui KS, Huang WJ et al (2022) Effects of different maize/soybean planting patterns on spatial distribution of soil organic matter and total nitrogen. Acta Agrestia Sinica 30(7): 1801-1810. (Chinese article with English abstract).
88. Xu M, Song C, Dai W et al (2015) Dynamics of soil phosphorus adsorption-desorption in maize/soybean relay intercropping. Chinese Journal of Applied Ecology 26(7): 1985-1991. (Chinese article with English abstract).
89. Xu YH, Wang C, Zheng DF et al (2017) Effects of the strip compound planting system on photosynthetic characteristics and grain yield of maize and soybean. Soybean Science 36(4): 540-546. (Chinese article with English abstract).
90. Yang F, Cui L, Huang S et al (2015) Soybean growth environment and group yield in soybean relay intercropped with different leaf type maize. Soybean Science 34(3): 402-407. (Chinese article with English abstract).
91. Yang F, Liao DP, Wu XL et al (2017) Effect of aboveground and belowground interactions on the intercrop yields in maize-soybean relay intercropping systems. Field Crops Research 203: 16-23.
92. Yang F, Lou Y, Liao DP et al (2015) Effects of row spacing on crop biomass, root morphology and yield in maize-soybean relay strip intercropping system. Acta Agronomica Sinica 41(4): 642-650. (Chinese article with English abstract).
93. Yang H, Zhou Y, Chen P (2022) Effects of nutrient uptake and utilization on yield of maize-legume strip intercropping system. Acta Agronomica Sinica 48(06): 1476-1487. (Chinese article with English abstract).
94. Yang K, Xu HL, Xu JY et al (2021) Study on yield and benefit of zonal compound planting pattern of maize and soybean. Journal of Anhui Agriculture Sciences 49(17): 40-42. (Chinese article with English abstract).
95. Yang L, Guo R, Liu Y et al (2022) Effects of maize-soybean intercropping and strip rotationon water, nitrogen utilizationand yield of maize in yellow river irrigated area of Ningxia. Acta Agriculturae Boreali-occidentalis Sinica (06): 755-765. (Chinese article with English abstract).
96. Yang SH, Qiu JX, Xu CS et al (2013) Effects of intercropping patterns on dry matter accumulation and transportation of maize and soybean. Journal of Anhui Agriculture Sciences 41(21): 8947-8949, 8964. (Chinese article with English abstract).
97. Yin YP, Zhang YQ, Shen YH et al (2014) Characteristics of maize/soybean intercropping system about root traits and absorption of nitrogen and phosphorus nutrient. Southwest China Journal of Agricultural Sciences 27(06): 2305-2310. (Chinese article with English abstract).
98. Yong TW, Liu XM, Liu WY et al (2014) Effects of reduced N application rate on yield

and nutrient uptake and utilization in maize-soybean relay strip intercropping system. Chinese Journal of Applied Ecology 25(2): 474-482. (Chinese article with English abstract).
99. Yu CB, Sun JH, Li L (2009) Effects of interspecific interactions on crop growth and nutrition accumulation. Plant Nutrition and Fertilizer science 15(1): 1-8. (Chinese article with English abstract).
100. Yu LL, Tang YL, Wang ZG et al (2019) Nitrogen-cycling genes and rhizosphere microbial community with reduced nitrogen application in maize/soybean strip intercropping. Nutrient Cycling in Agroecosystems 113:35-49.
101. Zeng TR, Wu YS, Xin YF et al (2022) Silage quality and output of different maize-soybean strip intercropping patterns. Fermentation 8(4): 174.
102. Zhang L, Zhang NM, Zhang SY et al (2019) Effects of AMF and intercropping on crop yield and soil nitrogen and phosphorus loss by runoff on slope farmland. Transactions of the Chinese Society of Agricultural Engineering 35(22): 216-224. (Chinese article with English abstract).
103. Zhang RZ, Meng LB, Li Y et al (2021) Yield and nutrient uptake dissected through complementarity and selection effects in the maize/soybean intercropping. Food and Energy Security 10(2): 379-393.
104. Zhang W, Li S, Shen Y et al (2021) Film mulching affects root growth and function in dryland maize-soybean intercropping. Field Crops Research 271: 108240-.
105. Zhang WP, Gao SN, Li ZX et al (2021) Shifts from complementarity to selection effects maintain high productivity in maize/legume intercropping systems. Journal of Applied Ecology 58:2603-2613.
106. Zhang XN, Chen P, Pang T et al (2017) The effects of dry matter accumulation, distribution and yield in the maize/soybean and maize/peanut intercropping system. Journal of Sichuan Agricultural University 35(04): 484-490. (Chinese article with English abstract).
107. Zhang XQ, Huang GQ, Bian XM et al (2012) Effects of intercropping on quality and yield of maize grain, microorganism quantity, and enzyme activities in soils. Acta Ecologica Sinica 32(22): 7082-7090. (Chinese article with English abstract).
108. Zhang XQ, Huang GQ, Bian XM et al (2012) Effects of intercropping and low-nitrogen fertilization on maize growth and yield in dryland. Agricultural Research in the Arid Areas 30(5): 30-36. (Chinese article with English abstract).
109. Zhang XQ, Huang GQ, Zhao QG (2014) Differences in maize physiological characteristics, nitrogen accumulation, and yield under different cropping patterns and nitrogen levels. Chilean Journal of Agricultural Research 74(3): 326-332.
110. Zhang XQ, Huang GQ, Zhao QG (2014) Effects of straw mulching on photosynthetic characteristics and yield of intercropped maize. Chinese Journal of Eco-Agriculture 22(4): 414-421. (Chinese article with English abstract).
111. Zhang YT, Liu J, Zhang JZ et al (2015) Row ratios of intercropping maize and soybean can affect agronomic efficiency of the system and subsequent wheat. Plos One 10(6): e0129245.
112. Zhang YT, Ren TZ, Liu HB et al (2015) Effect and mechanism of maize intercropping with soybean on reducing soil nitrogen residue in wheat-maize rotation. Scientia

Agricultura Sinica 48(13): 2580-2590. (Chinese article with English abstract).
113. Zhao DQ, Li T, Hou YT et al (2020) Benefits and marginal effect of dry matter accumulation and yield in maize and soybean intercropping patterns. Scientia Agricultura Sinica 53(10): 1971-1985. (Chinese article with English abstract).
114. Zhao DQ, Liu SH, Zhao KC (2020) Effect of maize-soybean intercropping and reduced nitrogen application on maize growth, yield and soil nitrate content. Acta Agriculturae Boreali-occidentalis Sincia 29(08): 1159-1166. (Chinese article with English abstract).
115. Zhao JH, Sun JH, Chen LZ et al (2020) Productivity and interspecific competition of maize intercropped with faba bean, soybean or pea. Acta Prataculturae Sincia 29(1): 85-94. (Chinese article with English abstract).
116. Zhao JH, Sun JH, Chen LZ et al (2022) Role of complementarity and select effect for yield advantage of maize/legumes intercropping systems. Acta Agronomica Sinica (10): 2588-2596. (Chinese article with English abstract).
117. Zhao JH, Sun JH, Chen W et al (2013) Yield and biomass accumulation of maize intercropped with different crops. Crops (04): 120-125. (Chinese article with English abstract).
118. Zhao JH, Sun JH, Fan TL et al (2015) Effect of row spacing of maize on yield and interspecific competition of crops in soybean /maize intercropping system. Agricultural Research in the Arid Areas 33(03): 159-163+183. (Chinese article with English abstract).
119. Zhou T, Wang L, Sun X et al (2021) Improved post-silking light interception increases yield and P-use efficiency of maize in maize/soybean relay strip intercropping. Field Crops Research 262: 108054.
120. Zhou Y, Chen P, Du Q et al (2018) The effects of agronomic traits of soybean and system economic benefits in the different intercropping patterns. Journal of Sichuan Agricultural Universit 36(06): 745-750. (Chinese article with English abstract).
121. Zhou YH, Fu ML, Cheng DR et al (2011) Benefit analysis on intercropping system of maize and potato, maize and soybean in arid land. Crop Research 25(05): 499-501.
122. Zhu XT, Chen JQ, Tan CY et al (2014) Optimization on plant row and spacing configuration of maize and soybean under 1:2 intercropping planting model. Soybean Science 33(1): 35-40. (Chinese article with English abstract).
123. Zhu YG, Gao FJ (2016) Effects of different maize and soybean intercropping patterns on population characteristics of photosynthetic and matter production in northwest Shandong region. Journal of Nuclear Agricultural Sciences 30(08): 1646-1655. (Chinese article with English abstract).
124. Zhu YG, Gao FJ, Cao PP et al (2015) Effect of plant density on population yield and economic output value in maize-soybean intercropping. Chinese Journal of Applied Ecology 26(6): 1751-1758. (Chinese article with English abstract).

Part2 The R code for NE calculating:

```
#R.3.6.3
#library(metafor)
#library(metagear)
#library(ggplot2)
#library(forestplot)
#Read the data into R
#d1<-read.csv("01-location-map-areas.csv")
#Estimate the lacked SD based on Bracken method
#d2<-impute_SD(d1,columnSDnames=c("SD_treat","SD_control"),columnXnames=c("Mean
_treat","Mean_control"), method = "Bracken1992")
#Calculate the NE for each study
#d3<-escalc(data=d2,measure="MD",n1i=Number_treat,n2i=Number_control,m1i=Mean_tre
at,m2i=Mean_control,sd1i=SD_treat,sd2i=SD_control)
#select data
#d4=d3[,c('Plain','yi','vi')]
#d4<-d4[!is.na(d4[,1]),]
#d4<-d4[!is.na(d4[,2]),]
#d4<-d4[!is.na(d4[,3]),]
##Calculate comprehensive effect NE for each area
#r61<-rma(yi,vi,data=subset(d4,Plain=="NEP"),method="REML")
#r62<-rma(yi,vi,data=subset(d4,Plain=="NCP"),method="REML")
#r63<-rma(yi,vi,data=subset(d4,Plain=="NWSA"),method="REML")
#r64<-rma(yi,vi,data=subset(d4,Plain=="YRB"),method="REML")
#r65<-rma(yi,vi,data=subset(d4,Plain=="SC"),method="REML")
##Result select and output
#a<-r61
#b<-r62
#c<-r63
#d<-r64
#e<-r65
#estimates2<- c("mean",coef(a), coef(b),coef(c),coef(d),coef(e))
#lower<-c("lower",a$ci.lb,b$ci.lb,c$ci.lb,d$ci.lb,e$ci.lb)
#upper<-c("upper",a$ci.ub,b$ci.ub,c$ci.ub,d$ci.ub,e$ci.ub)
#n<-c("n",a$k,b$k,c$k,d$k,e$k)
#sink("2.out.txt")
#cat(estimates2,lower,upper,n)
#sink()
```

Part3 The R code for LER calculating:

```
##Read data into R
#d1<-read.csv("01-location-map-areas-LER.csv")
##Estimate the lacked SD
#d2<-impute_SD(d1,columnSDnames=c("SD_treat","SD_control"),columnXnames=c("Mean
```

```
_treat","Mean_control"), method = "Bracken1992")
# Calculate the LER for each study
#d3<-escalc(data=d2,measure="ROM",n1i=Number_treat,n2i=Number_control,m1i=Mean_tr
eat,m2i=Mean_control, sd1i=SD_treat,sd2i=SD_control)
#Select data
#d4=d3[,c('Plain','yi','vi')]
#d4<-d4[!is.na(d4[,1]),]
##d4<-d4[!is.na(d4[,2]),]
#d4<-d4[!is.na(d4[,3]),]
#Calculate comprehensive effect LER for each area
#d5=d4
#r61<-rma(yi,vi,data=subset(d5,Plain=="Northeast"),method="REML")
#r62<-rma(yi,vi,data=subset(d5,Plain=="Northeast"),method="REML")
#r63<-rma(yi,vi,data=subset(d5,Plain=="Northwest"),method="REML")
#r64<-rma(yi,vi,data=subset(d5,Plain=="Northwest"),method="REML")
#r65<-rma(yi,vi,data=subset(d5,Plain=="North China Plain"),method="REML")
#r66<-rma(yi,vi,data=subset(d5,Plain=="North China Plain"),method="REML")
#r67<-rma(yi,vi,data=subset(d5,Plain=="Yangtze River Basin"),method="REML")
#r68<-rma(yi,vi,data=subset(d5,Plain=="Yangtze River Basin"),method="REML")
#r69<-rma(yi,vi,data=subset(d5,Plain=="South China"),method="REML")
#r70<-rma(yi,vi,data=subset(d5,Plain=="South China"),method="REML")
#Select and output the result
#a<-r61
#b<-r62
#c<-r63
#d<-r64
#e<-r65
#g<-r66
#h<-r67
#i<-r68
#j<-r69
#k<-r70
#estimates2<-c("mean",coef(a),coef(b),coef(c),coef(d),coef(e),coef(g),coef(h),coef(i),coef(j),c
oef(k))
#lower<-c("lower",a$ci.lb,b$ci.lb,c$ci.lb,d$ci.lb,e$ci.lb,g$ci.lb,h$ci.lb,i$ci.lb,j$ci.lb,k$ci.lb)
#upper<-c("upper",a$ci.ub,b$ci.ub,c$ci.ub,d$ci.ub,e$ci.ub,g$ci.ub,h$ci.ub,i$ci.ub,j$ci.ub,k$c
i.ub)
#n<-c("n",a$k,b$k,c$k,d$k,e$k,g$k,h$k,i$k,j$k,k$k)
#sink("2.out.txt")
#cat(estimates2,lower,upper,n)
#sink()
```

Part4 The R code for the relationships between the NE (a-j) and the LER (k-t) and influencing factors under intercropping

```
#library(party)
#library(tidyverse)
#library(ggplot2)
#Read the data into R
#d1<-read.csv("03-intercrop-meta-LER-1.csv")
set.seed(1000)
#Data clearing
#d1 %>% mutate( Soil.types = as.factor(Soil.types), row.ratio= as.factor(row.ratio), H.index=as.numeric(H.index) , Accum.temp=as.numeric(Accum.temp)) %>% as_tibble() ->d1_1
##
#require(gridExtra)
####The influence of sunshine
#d3<-d1
#d4=d3[,c('Sunshine','RR')]
#d4<-d4[!is.na(d4[,1]),]
#p<-ggplot(data=d4,aes(x=Sunshine,y=RR))+theme(panel.grid=element_blank(), panel.background=element_rect(fill='transparent', color= 'black'))+geom_point(col=636)+ylab("LER")+xlab("(k) Accum. sunshine (hour)")
#p11<-p+stat_smooth(method=lm,formula=y~x,col="black")+geom_hline(yintercept=c(1))
#p11
####The influence of precipitation
#d3<-d1
#d4=d3[,c('Precipitation','RR')]
#d4<-d4[!is.na(d4[,1]),]
#p<-ggplot(data=d4,aes(x=Precipitation,y=RR))+theme(panel.grid=element_blank(), panel.background=element_rect(fill='transparent',
color='black'))+geom_point(col=636)+xlab("(l) Precipitation (mm)")+ylab(NULL)
#p12<-p+stat_smooth(method='loess',span=5,se=TRUE,level=0.95,col="black")+geom_hline (yintercept=c(1))
#p12
####The influence of temperature
#d3<-d1
#d4=d3[,c('Temperature','RR')]
#d4<-d4[!is.na(d4[,1]),]
#p<-ggplot(data=d4,aes(x=Temperature,y=RR))+theme(panel.grid=element_blank(), panel.background=element_rect(fill='transparent',
color='black'))+geom_point(col=636)+xlab("(m) Temperature (degree)")+ylab(NULL)
#p13<-p+stat_smooth(method='loess',span=5,se=TRUE,level=0.95,col="black")+geom_hline (yintercept=c(1))
p13
####The influence of total K
```

```
#d3<-d1
#d4=d3[,c('K','RR')]
#d4<-d4[!is.na(d4[,1]),]
#p<-ggplot(data=d4,aes(x=K,y=RR))+theme(panel.grid=element_blank(),
panel.background=element_rect(fill='transparent',
color='black'))+geom_point(col=636)+xlab("(n) Total K (g kg-1)")+ylab(NULL)
#p14<-p+stat_smooth(method='loess',span=5,se=TRUE,level=0.95,col="Brown")+geom_hlin
e(yintercept=c(1))
#p14
#### The influence of total a.P
#d3<-d1
#d4=d3[,c('a.P','RR')]
#d4<-d4[!is.na(d4[,1]),]
#p<-ggplot(data=d4,aes(x=a.P,y=RR))+theme(panel.grid=element_blank(),
panel.background=element_rect(fill='transparent',
color='black'))+geom_point(col=636)+xlab("(p) Available P (mg kg-1)")+ylab("LER")
p15<-p+stat_smooth(method=lm,formula=y~x,level=0.95,span=1,col="Brown")+geom_hline
(yintercept=c(1))
#p15
### The influence of total a.K
#d3<-d1
#d4=d3[,c('a.K','RR')]
#d4<-d4[!is.na(d4[,1]),]
#p<-ggplot(data=d4,aes(x=a.K,y=RR))+theme(panel.grid=element_blank(),
panel.background=element_rect(fill='transparent',
color='black'))+geom_point(col=636)+xlab("(o) Available K (mg kg-1)")+ylab(NULL)
#p16<-p+stat_smooth(method='loess',span=5,se=TRUE,level=0.95,col="Brown")+geom_hlin
e(yintercept=c(1))
#p16
## The influence of total pH
#d3<-d1
#d4=d3[,c('PH','RR')]
#d4<-d4[!is.na(d4[,1]),]
#p<-ggplot(data=d4,aes(x=PH,y=RR))+theme(panel.grid=element_blank(),
panel.background=element_rect(fill='transparent',
color='black'))+geom_point(col=636)+xlab("(q) pH")+ylab(NULL)
p17<-p+stat_smooth(method=lm,formula=y~x,level=0.95,span=1,col="Brown")+geom_hline
(yintercept=c(1))
#p17
#### The influence of delay time
#d3<-d1
#d4=d3[,c('soybean.delay.time','RR')]
#d4<-d4[!is.na(d4[,1]),]
#p<-ggplot(data=d4,aes(x=soybean.delay.time,y=RR))+theme(panel.grid=element_blank(),
```

```
panel.background=element_rect(fill='transparent',
color='black'))+geom_point(col=636)+xlab("(r) Soybean delay (day)")+ylab(NULL)
p18<-p+stat_smooth(method='loess',span=5,se=TRUE,level=0.95)+geom_hline(yintercept=c(
1))
#p18
#### The influence of row distance
#d3<-d1
#d4=d3[,c('MS.row.distance','RR')]
#d4<-d4[!is.na(d4[,1]),]
#p<-ggplot(data=d4,aes(x=MS.row.distance,y=RR))+theme(panel.grid=element_blank(),
panel.background=element_rect(fill='transparent',
color='black'))+geom_point(col=636)+xlab("(s) MS.row.distance (cm)")+ylab(NULL)
#p19<-p+stat_smooth(method='loess',span=2,se=TRUE,level=0.95)+geom_hline(yintercept=
c(1))
#p19
#### The influence of maize seed density
#d3<-d1
#d4=d3[,c('inter.maize.density','RR')]
#d4<-d4[!is.na(d4[,1]),]
#p<-ggplot(data=d4,aes(x=inter.maize.density,y=RR))+theme(panel.grid=element_blank(),
panel.background=element_rect(fill='transparent',
color='black'))+geom_point(col=636)+xlab("(t) M.density (10^4 plants ha-1)")+ylab(NULL)
#p20<-p+stat_smooth(method='loess',span=5,se=TRUE,level=0.95)+geom_hline(yintercept=
c(1))
#p20
##Draw the figure
#grid.arrange(p11,p12,p13,p14,p16,p15,p17,p18,p19,p20,ncol=5)
#grid.arrange(p1,p2,p3,p4,p5,p6,p7,p8,p9,p10,p11,p12,p13,p14,p16,p15,p17,p18,p19,p20,nco
l=5)
```