

# Identification of high value crops potentially adapted to soil and climate in Gulang County, Gansu, China

## Site description & crop evaluation



Photo: China Daily

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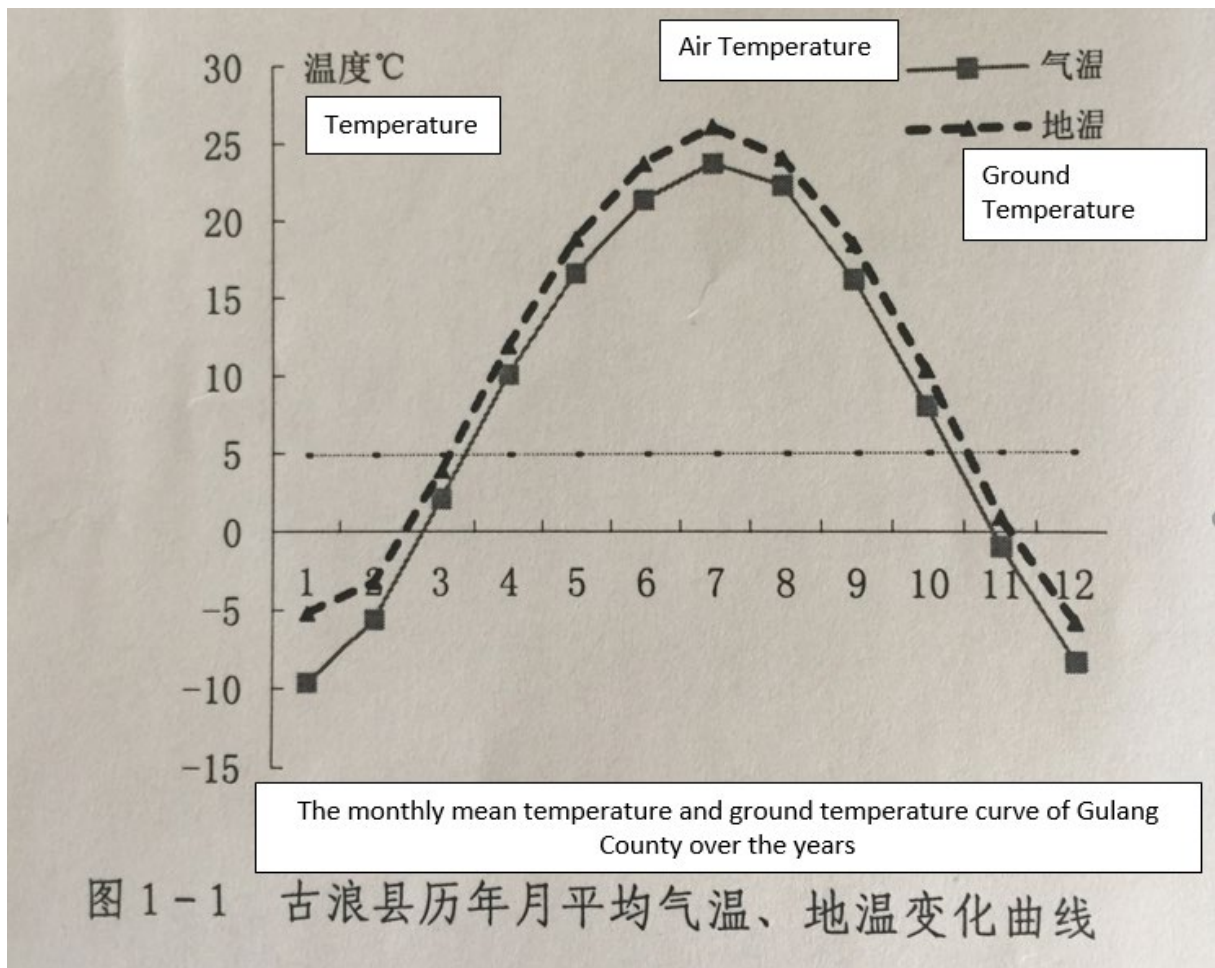
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# 1 Introduction

Gulang County is located in Gansu Province, Northern China bordering the Gobi desert. It has a cold and dry climate with a mean annual temperature of about 6°C and an annual precipitation of around 280 mm (Figure 1). According to the Köppen-Geiger classification, the climate in the region is between cold semi-arid (BSk) and subarctic (Dwc) (Rubel & Kottek, 2010).

The actual cultivated land of Gulang County is around 60'000 ha, about half of which is irrigated and the other half used by rainfed agriculture (Table 1). The main field crops are wheat, maize and potato, while vegetables such as pepper, onion, baby Chinese cabbage, tomato, garlic shoots, lettuce, cabbage, melons and eggplant are grown both in the open field and in the greenhouse. The major greenhouse crops are pepper, tomato, melon, eggplant and grape and grown all year round. Stoves are used to heat the greenhouses in very cold days (less than 10 days a year). The greenhouse temperature is estimated to be 8-30°C with a relative humidity of about 60% (Table 1). There is about 600 mm of water available for irrigation if the weather is not too dry. The soil in Gulang County is moderately alkaline with relatively low levels of soil organic matter and available macronutrients (Table 1).



**Figure 1:** The monthly mean temperature and ground temperature curve of Gulang County over the years

The aim of this study was to assess agricultural diversification opportunities for farmers in Gulang County, based on the local biophysical conditions and to identify promising high value crops for cultivation. The following questions were addressed:

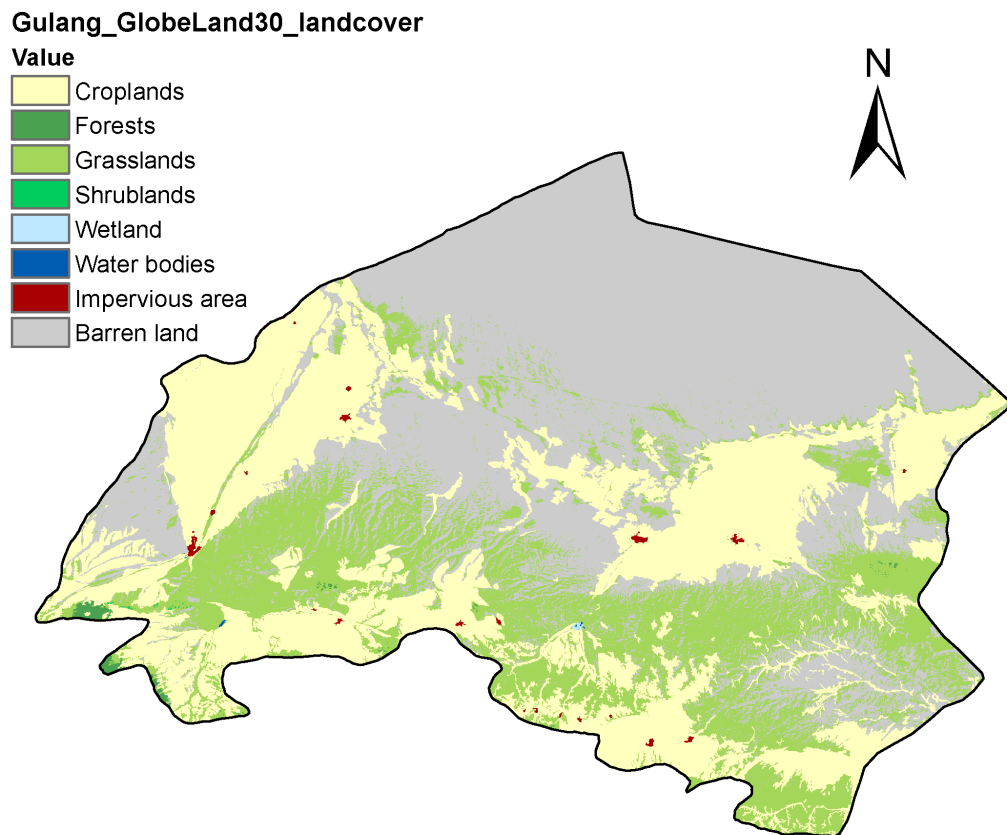
- What is the range of soil, landscape and climate variables in Gulang County?
- What high value crops can potentially be cultivated under the current biophysical conditions based on their requirements?
- What are the main limitations for crop production in Gulang County?

**Table 1:** Characteristics of the agricultural area in Gulang County. The data was gathered by local partners of the Syngenta Foundation for Sustainable Agriculture.

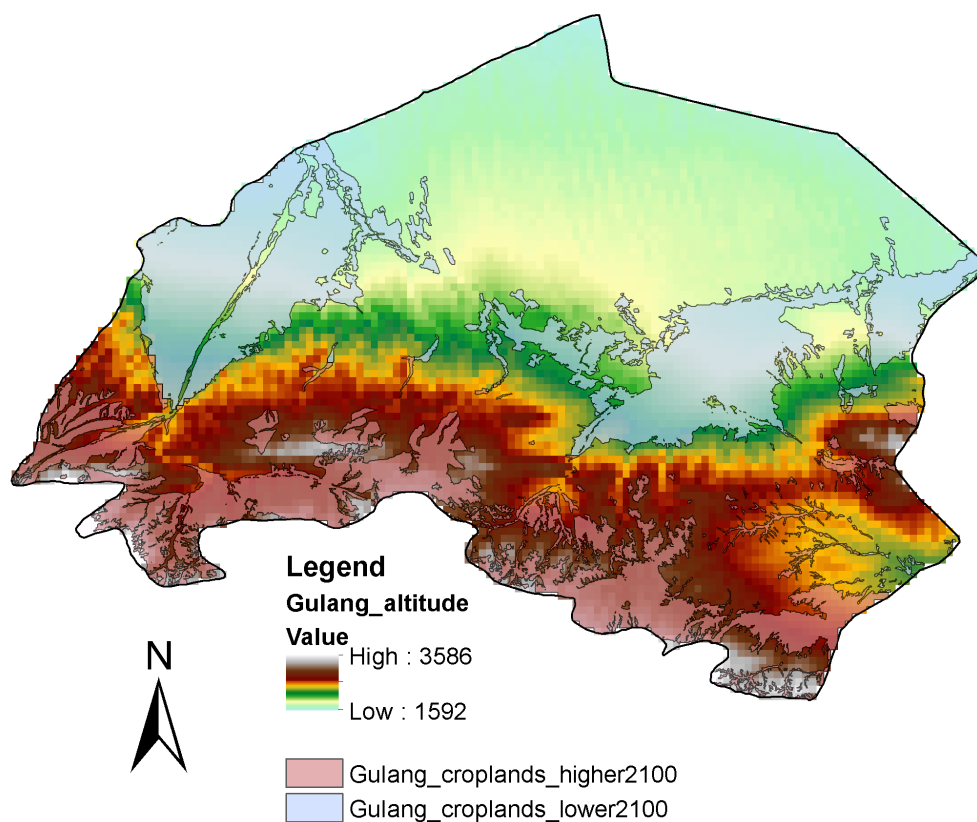
<b>Arable land</b>	<b>[ha]</b>	
total arable land	72667	
actual cultivated area	60000	
irrigated area	33333	
rainfed area	26667	
vegetables cultivated	8667	
vegetables in greenhouses	867	
<b>Major field crops</b>	<b>[ha]</b>	<b>type</b>
wheat	8000	irrigated
maize	10667	irrigated
potato	6667	half irrigated, half rainfed
<b>Vegetables (open field &amp; greenhouse)</b>	<b>[ha]</b>	<b>type</b>
pepper	1333	irrigated
onion	1333	irrigated
baby Chinese cabbage (娃娃菜)	667	irrigated
tomato	667	irrigated
garlic shoots	333	irrigated
lettuce	333	irrigated
cabbage	333	irrigated
melons	333	irrigated
eggplant	67	irrigated
<b>Water availability</b>	<b>[t/ha]</b>	<b>[mm]</b>
Yellow River	6000	600
3 local reservoirs	?	?
<b>Soil Characteristics</b>		<b>unit</b>
soil pH	8 to 8.5	
soil organic matter content	13.9	[g/kg]
total nitrogen	0.82	[g/kg]
fast-acting phosphorus	8	[mg/kg]
available potassium	232	[mg/kg]

## 2 Methods

The investigation of biophysical parameters of Gulang County were restricted to croplands based on the Chinese land cover dataset GlobeLand30 in 30 m resolution (Figure 2 and Table 2). Additionally, due to the fact that croplands in Gulang County are located in areas with very variable terrain, the cropland area was divided into the agricultural area below and above an altitude of 2100 m asl for any further investigation (Figure 3).



**Figure 2:** Land cover classification of Gulang County based on the GlobeLand30 dataset.



**Figure 3:** Altitude of Gulang County and the division of croplands into areas below (blue) and above (red) 2100 m asl

The FAO ECOCROP database was used to find suitable crops for cultivation in Gulang County (FAO, 2003). The ECOCROP parameters relevant for our search were the related to the ecological niche of a certain plant species:

- Climate zone (Köppen-Geiger)
- Latitude
- Altitude
- Available field days
- Temperature
- Rainfall
- Soil pH
- Soil depth
- Soil texture
- Soil salinity
- Soil drainage

The ECOCROP parameters light intensity, photoperiod and soil fertility were not included in our study because they are classified parameters that could either not be related to a relevant local dataset or that could be improved by agronomic practices.

Different global and regional datasets (Table 2) were used to match the biophysical information required by the ECOCROP database. All biophysical parameters were determined separately for the croplands lower and higher than 2100 m asl (mean values and regional variation). The ECOCROP database search requires temperature information about the crop growing season of interest. Therefore, only months with an average temperature above 5°C were taken into account for the growing season, based on a literature search (EEA, 2012; Sobolowski, n.d.). Accordingly, 7 months (April – October) and 5 months (May – September) for the cropland area below and above 2'100 m asl, respectively, were used to calculate the available field days and the average minimum and maximum temperatures of the growing season.

**Table 2:** Administrative and biophysical parameters and datasets used in the assessment.

Parameter	Unit	Data Source
Gulang County		ESRI World administrative divisions
<b>Climate</b>		
Köppen-Geiger climate classification	class	ESRI Köppen-Geiger
Annual precipitation	mm	WorldClim BIO12
Precipitation seasonality (CV)		WorldClim BIO15
Mean monthly minimum temperature	°C	WorldClim
Mean monthly maximum temperature	°C	WorldClim
<b>Soil</b>		
Soil depth	cm	SoilGrids
Soil pH		SoilGrids
Soil texture	Class	SoilGrids
Soil salinity (ECe)	dS/m	Harmonised World Soil Database (HWSD)
Drainage	class	Harmonised World Soil Database (HWSD)
<b>Landscape</b>		
Altitude	m asl	ESRI Terrain Service
Slope	%	ESRI Terrain Service
Croplands	Class	GlobeLand30 land cover

Different scenarios were defined to carry out the ECOCROP database requests. The factors taken into account were the altitude (lower than 2'100, higher than 2'100 m asl), the cultivation practice (open field, greenhouse) and the irrigation practice (rainfed, irrigated) resulting in 6 combinations:

- Lower\_open\_rainfed
- Lower\_open\_irrigated
- Lower\_greenhouse
- Higher\_open\_rainfed
- Higher\_open\_irrigated
- Higher\_greenhouse

For irrigated agriculture, 600 mm of water was added to the precipitation values (Table 1). Cultivation in the greenhouse was approximated using minimum and maximum temperatures of 8 and 30°C and 600

mm of water available for irrigation. For each scenario, the ECOCROP database request was first carried out taking into account all relevant biophysical parameters (Tables 3 and 4). Then, combination of ecological parameters taken into account was reduced step-wise to avoid being too restrictive in the database query (Table 5). Additionally, the ECOCROP database offers optimal and absolute requests for the temperature, rainfall, latitude, soil pH and light intensity parameters. Absolute requests were used throughout this study to identify all potentially suitable crops for the region of interest.



### 3 Results & Discussion

#### 3.1 Gulang County site characterization

The total cropland area in Gulang County, based on the GlobeLand30 dataset is 256'471 ha with 144'724 ha located below and 111'747 ha above 2'100 m asl. This is more than three times larger than the area reported by our local partners (72'667 ha, see Table 1) and we currently do not know what part of the agricultural area is represented by this number.

The lower croplands of Gulang County are located at an average altitude of 1'805 m asl while the lower croplands are at 2'492 m asl (Table 3 and 4). Therefore, they differ in average minimum and maximum temperature of the growing cycle, annual rainfall and available field days as can be seen in Tables 3 and 4 and Figures A2-A4. In most agricultural areas, the soil pH is moderately alkaline with some exceptions in the Southwestern and Eastern parts of Gulang County with lower soil pH values. Soil texture (loam), salinity (low) and drainage (moderately well) conditions are optimal for most agricultural crops.

**Table 3:** Biophysical conditions and input parameters for lower croplands of Gulang County.

ECOCROP parameter	lower than 2100 m asl					
	open (rainfed)		open (irrigated)		greenhouse	
	min	max	min	max	min	max
Temperature (°C)	8.3	21.3	8.3	21.3	8	30
Annual rainfall (mm)	209	247	809	847	600	600
Soil pH	8.1	8.4	8.1	8.4	8.1	8.4
	mean		mean		mean	
Climate zone (Köppen-Geiger)	BSk		BSk			
Latitude (°)	37		37			
Altitude (m asl)	1805		1805			
Available field days	210		210			
Soil depth (cm)	200		200		200	
Soil texture	Loam (medium)		Loam (medium)		Loam (medium)	
Soil salinity (dS/m)	0.3 (low)		0.3 (low)		0.3 (low)	
Soil drainage	moderately well		moderately well		moderately well	
Slope (%)	1.7		1.7			

**Table 4:** Biophysical conditions and input parameters for higher croplands of Gulang County.

ECOCROP parameter	higher than 2100 m asl					
	open (rainfed)		open (irrigated)		greenhouse	
	min	max	min	max	min	max
Temperature (°C)	6.2	19.5	6.2	19.5	8	30
Annual rainfall (mm)	316	380	916	980	600	600
Soil pH	7	8.5	7	8.5	7	8.5
	mean		mean		mean	
Climate zone (Köppen-Geiger)	Dwc		Dwc			
Latitude (°)	37		37			
Altitude (m asl)	2492		2492			
Available field days	150		150			
Soil depth (cm)	200		200		200	
Soil texture	Loam (medium)		Loam (medium)		Loam (medium)	
Soil salinity (dS/m)	1 (low)		1 (low)		1 (low)	
Soil drainage	moderately well		moderately well		moderately well	
Slope (%)	5.1		5.1			

### 3.2 Gulang County potential crop identification

Applying ECOCROP database queries for the different scenarios resulted in different numbers of potentially suitable crops identified (Table 5). With some exceptions, generally the numbers increased with irrigation and under greenhouse conditions. Not surprisingly, the numbers of potential crops also increased by reducing the number of input parameters.

**Table 5:** Number of crops identified by ECOCROP database queries using different sets of input parameters.

ECOCROP parameter	search 1	search 2	search 2_2	search 3	search 3_2	search 4	search 5
			greenhouse		greenhouse		
Temperature (°C)	x	x	x	x	x	x	x
Annual rainfall (mm)	x	x	x	x	x	x	x
Soil pH	x	x	x				
Climate zone (Köppen-Geiger)	x						
Latitude (°)	x						
Altitude (m asl)	x						
Available field days	x	x		x		x	
Soil depth (cm)	x	x	x	x	x		
Soil texture	x	x	x	x	x		
Soil salinity (dS/m)	x	x	x	x	x		
Soil drainage	x	x	x	x	x		
lower_open_rainfed	11	44		96		108	112
lower_open_irrigated	27	93		521		546	603
lower_greenhouse			99		387		423
higher_open_rainfed	5	64		209		235	250
higher_open_irrigated	5	50		292		314	405
higher_greenhouse			95		387		423

Table 6 shows all high potential crops identified by the first search including all ECOCROP parameters listed in Table 5. Quinoa, chickpea and amaranth were classified as high potential crops because they are currently very popular in Europe. *Apocynum venetum*, a close relative to *Apocynum cannabinum* that was identified in the database search, was found to be cultivated as a herbal tea in China and therefore regarded as a high potential crop (Xinhua, 2016). The full list of crops identified can be found in Table A1. There were some food vegetables (legumes, tubers, cereals) found that were classified as moderate potential crops.

**Table 6:** List of high potential crops identified by search 1 (see Table 5) for open fields, rainfed or irrigated, in lower and higher cropland areas.

	lower croplands		higher croplands		remark
	rainfed	irrigated	rainfed	irrigated	
<i>Amaranthus caudatus</i>		x			food, proteins, Gartenfuchsschwanz
<i>Apocynum cannabinum</i>	x	x			<i>Apocynum venetum</i> (herbal tea, China)
<i>Chenopodium quinoa</i>		x	x	x	quinoa, food
<i>Cicer arietinum</i>		x			chickpea, food
<i>Elaeagnus angustifolia</i>			x		Russian olive, food, Norouz (Persian festival)

When the climate zone, latitude and altitude parameters were left out from the database query, many more crops were identified (Table 5 and 7). The perennial high value crops that were now identified have to be regarded carefully (e.g. *Anacardium occidentale* (cashew), *Elaeagnus angustifolia*, *Ficus carica* (fig), *Mangifera indica* (mango), *Moringa oleifera*, *Punica granatum* (grenadine), *Santalum acuminatum*, *Schinus molle*). They were found using the climate conditions of the growing season only and might not tolerate the low winter temperatures in Gulang County. Therefore, their frost tolerance should be checked carefully (see Chapter 4). There were two belowground crop products identified (*Apios americana*, *Lepidium meyenii*) that could potentially be of interest, especially the Peruvian high value crop maca that is already grown in certain regions of China (Brand, 2016). Additionally, *Parthenium argentatum* could be used for rubber production (guayule) as an alternative to latex. Compared to search 1, some more vegetables of moderate potential were found (e.g. garlic, horseradish, see Table A2).

**Table 7:** List of high potential crops identified by search 2 (see Table 5) for open fields, rainfed or irrigated, in lower and higher cropland areas.

	lower croplands		higher croplands		remark
	rainfed	irrigated	rainfed	irrigated	
<i>Aegle marmelos</i>		x			bel fruit, bengalische Quitte
<i>Amaranthus sp.</i>	x	x			food, fibre, various uses
<i>Amaranthus caudatus</i>		x			food, proteins, Gartenfuchsschwanz
<i>Anacardium occidentale</i>		x			cashew
<i>Apios americana</i>		x			American groundnut, potato bean
<i>Apocynum cannabinum</i>	x	x	x	x	Apocynum venetum (herbal tea, China)
<i>Chenopodium ambrosioides</i>		x	x	x	Mexican tea
<i>Chenopodium pallidicaule</i>		x	x	x	close to quinoa
<i>Chenopodium quinoa</i>		x	x	x	quinoa, food
<i>Cicer arietinum</i>		x			chickpea, food
<i>Elaeagnus angustifolia</i>			x		Russian olive, food, Norouz (Persian festival)
<i>Ficus carica</i>		x	x	x	common fig
<i>Indigofera tinctoria</i>		x			indigo, dye
<i>Lepidium meyenii</i>		x			maca, Peru ginseng
<i>Mangifera indica</i>		x			mango
<i>Moringa oleifera</i>		x			horseradish tree, moringa
<i>Parthenium argentatum</i>		x			guayule, Gummibaum
<i>Punica granatum</i>		x			pomegranate, grenadine, Chinese apple
<i>Santalum acuminatum</i>	x		x		desert peach (Australia), quandong, food, various uses

By removing the soil pH restrictions in the search, lists of several hundred crops were found (Table 5). From these lists, only the crops that could potentially be of interest and that were not already included in Table 6 and 7 were retrieved (Table A3). Among these crops, there are many herbs and vegetables that were not classified as high potential crops. The species regarded as high potential crops (Table 8) were mainly different types of berries (sea buckthorn, goji berry, black and red current, gooseberry, raspberry, blueberry, cranberry, elderberry), Andean tuber crops (oca, mauka, yacon, mashua, ulluco) and some specialties (artichoke, kiwi, saffron, crown daisy, asparagus, liquorice).

**Table 8:** List of high potential crops identified by search 3 (see Table 5) not already included in Tables 6 and 7 for open fields, rainfed or irrigated, in lower and higher cropland areas.

	lower croplands		higher croplands		remark
	rainfed	irrigated	rainfed	irrigated	
<i>Actinidia chinensis</i>		x			Chinese gooseberry, Kiwifruit
<i>Asparagus officinalis</i>		x			asparagus
<i>Chrysanthemum coronarium</i>		x			crown daisy, food, Asian cuisine
<i>Corylus avellana</i>		x		x	hazel nut, Haselnuss
<i>Crocus sativus</i>		x			saffron
<i>Cynara scolymus</i>		x			artichoke
<i>Glycyrrhiza glabra</i>		x	x	x	liquorice, Süssholz
<i>Hippophae rhamnoides</i>	x		x		sea buckthorn, Sanddorn, China ( <i>Hippophae gonocarpa</i> )
<i>Hippophae salicifolia</i>	x		x		sea buckthorn, Himalaya
<i>Lycium chinese</i>		x			Goji, boxthorn
<i>Mirabilis expansa</i>		x			mauka, yuca, root vegetable, Andean
<i>Oxalis tuberosa</i>		x			oca, Knollen-Sauerklee
<i>Polymnia sonchifolia</i>		x			yacon, Peruvian ground apple, Andean root vegetable
<i>Ribes sp.</i>		x		x	black currant, red current, gooseberry, Johannisbeeren, Stachelbeeren
<i>Rubus sp.</i>		x	x	x	rasperry, black rasperry, dewberry, Himbeere
<i>Sambucus canadensis</i>		x	x	x	common elder, Holunder
<i>Tropaeolum tuberosum</i>		x			mashua, mashwa, tuber vegetable, Peru, Ecuador
<i>Ullucus tuberosus</i>		x		x	ulluco, root vegetable, South America
<i>Vaccinium sp.</i>		x		x	blueberry, cranberry, Moosbeere, Blaubeere

Due to the high number of crops identified in searches 4 and 5 and the low restriction due to the small number of input parameters, they were not further investigated.

For the greenhouse scenarios, two ECOCROP database searches were performed, with and without pH restrictions, resulting in 95-99 and 387 potential crops, respectively (Table 5). Tables A4 and A5 show the lists of crops that are potentially of interest. However, among these crops there are many perennial crops that are not feasible for greenhouse cultivation. Still, there was a great variety of vegetable species identified that could be grown in the greenhouse. However, this list was not further elaborated because of the high uncertainty about the microclimatic conditions of the greenhouses and therefore the plausibility of this list.

## 4 Conclusions

The potential crops identified for the open field (Tables 6, 7 and 8) were carefully checked for their frost tolerance and cold hardiness. Perennial crops that cannot withstand temperatures below -10°C (average temperature in January, Figure 1) were eliminated from the list. The resulting list of the most promising crops is presented in Table 9. The crops identified mainly belong to berries (*Hippophae*, *Lycium*, *Ribes sp.*, *Rubus sp.*, *Sambucus*, *Vaccinium sp.*) or tuber/below-ground crops (*Apios*, *Lepidium*, *Mirabilis*, *Oxalis*, *Polymnia*, *Tropaeolum*, *Ullucus*). Additionally, there are some pseudocereals (*Amaranthus sp.*, *Chenopodium sp.*) and specialty crops (*Apocynum*, *Cicer*, *Corylus*, *Glycyrrhiza*, *Parthenium*).

A thorough analysis of the market situation and cultivation guidelines for these crops will reveal which ones really have a potential for agricultural diversification of the Gulang County region. Further considerations about the integration into crop rotations or the identification of closely related crops not adequately represented in the ECOCROP database (such as *Aronia alnifolia*, *Amelanchier pallida*, *Cornus mas*) will support decision-making.

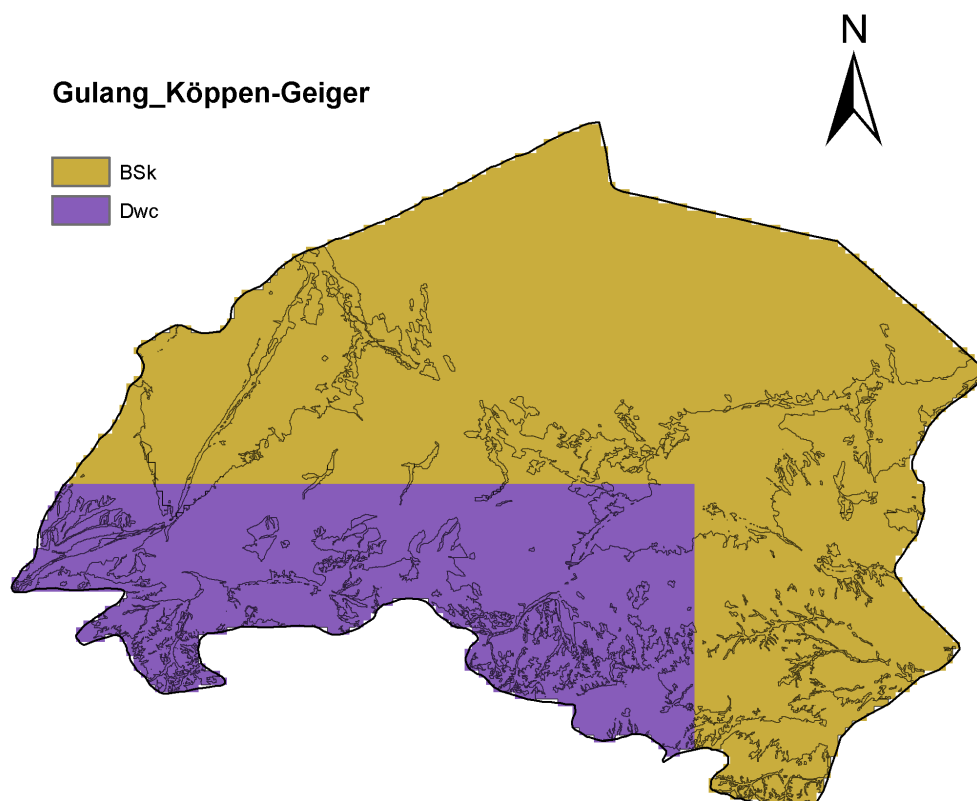
**Table 9:** High potential crops identified by searches 1, 2 and 3 without perennial crops that are not frost tolerant for open fields, rainfed or irrigated, in lower and higher cropland areas.

	lower croplands		higher croplands		remark
	rainfed	irrigated	rainfed	irrigated	
<i>Amaranthus sp.</i>	x	x			food, fibre, various uses
<i>Apios americana</i>		x			American groundnut, potato bean
<i>Apocynum cannabinum</i>	x	x	x	x	<i>Apocynum venetum</i> (herbal tea, China)
<i>Chenopodium sp.</i> (ambrosioides, pallidicaule, quinoa)		x	x	x	Mexican tea, quinoa, food
<i>Chrysanthemum coronarium</i>		x			crown daisy, food, Asian cuisine
<i>Cicer arietinum</i>		x			chickpea, food
<i>Corylus avellana</i>		x		x	hazel nut, Haselnuss
<i>Cynara scolymus</i>		x			artichoke
<i>Glycyrrhiza glabra</i>		x	x	x	liquorice, Süssholz
<i>Hippophae rhamnoides</i> , <i>salicifolia</i>	x		x		sea buckthorn, Sanddorn, China ( <i>Hippophae goniocarpa</i> )
<i>Lepidium meyenii</i>		x			maca, Peru ginseng
<i>Lycium chinese</i>		x			Goji, boxthorn
<i>Mirabilis expansa</i>		x			mauka, yuca, root vegetable, Andean
<i>Oxalis tuberosa</i>		x			oca, Knollen-Sauerklee
<i>Parthenium argentatum</i>		x			guayule, Gummibaum
<i>Polymnia sonchifolia</i>		x			yacon, Peruvian ground apple, Andean root vegetable
<i>Ribes sp.</i> ( <i>nigrum</i> , <i>hirtellum</i> , <i>rubrum</i> , <i>sativum</i> , <i>uva-crispa</i> )		x		x	black currant, red current, gooseberry, Johannisbeeren, Stachelbeeren
<i>Rubus sp.</i> ( <i>fruticosus</i> , <i>idaeus</i> , <i>occidentalis</i> )		x	x	x	raspberry, black raspberry, dewberry, Himbeere
<i>Sambucus canadensis</i>		x	x	x	common elder, Holunder
<i>Tropaeolum tuberosum</i>		x			mashua, mashwa, tuber vegetable, Peru, Ecuador
<i>Ullucus tuberosus</i>		x		x	ulluco, root vegetable, South America
<i>Vaccinium sp.</i> ( <i>angustifolium</i> , <i>corymbosum</i> , <i>macrocarpon</i> , <i>myrtillus</i> , <i>vitis-idaea</i> )		x		x	blueberry, cranberry, Moosbeere, Blaubeere

## 5 References

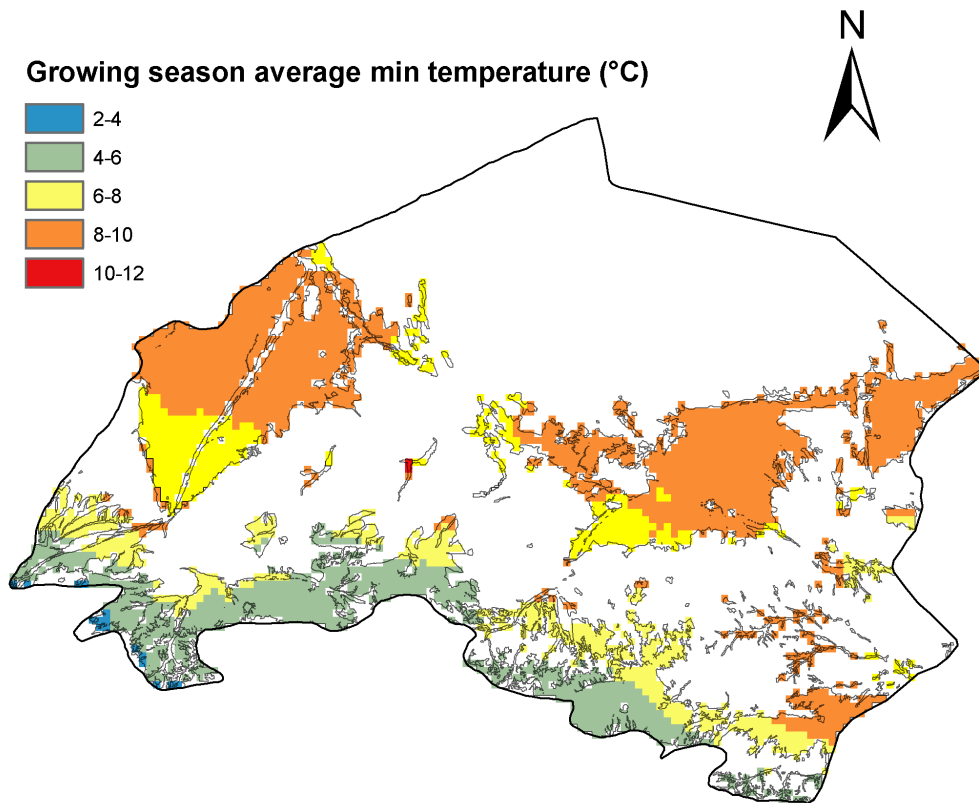
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## 6 Appendix

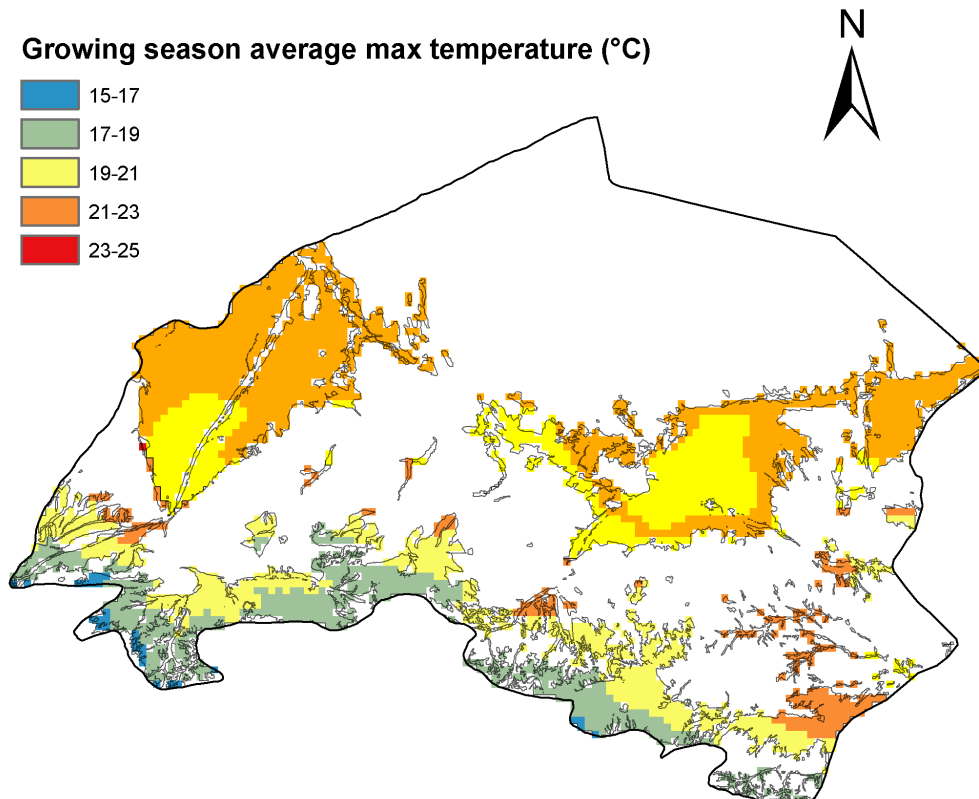


**Figure A1:** Climate of Gulang County classified according to Köppen-Geiger (Rudel & Kottek, 2010).

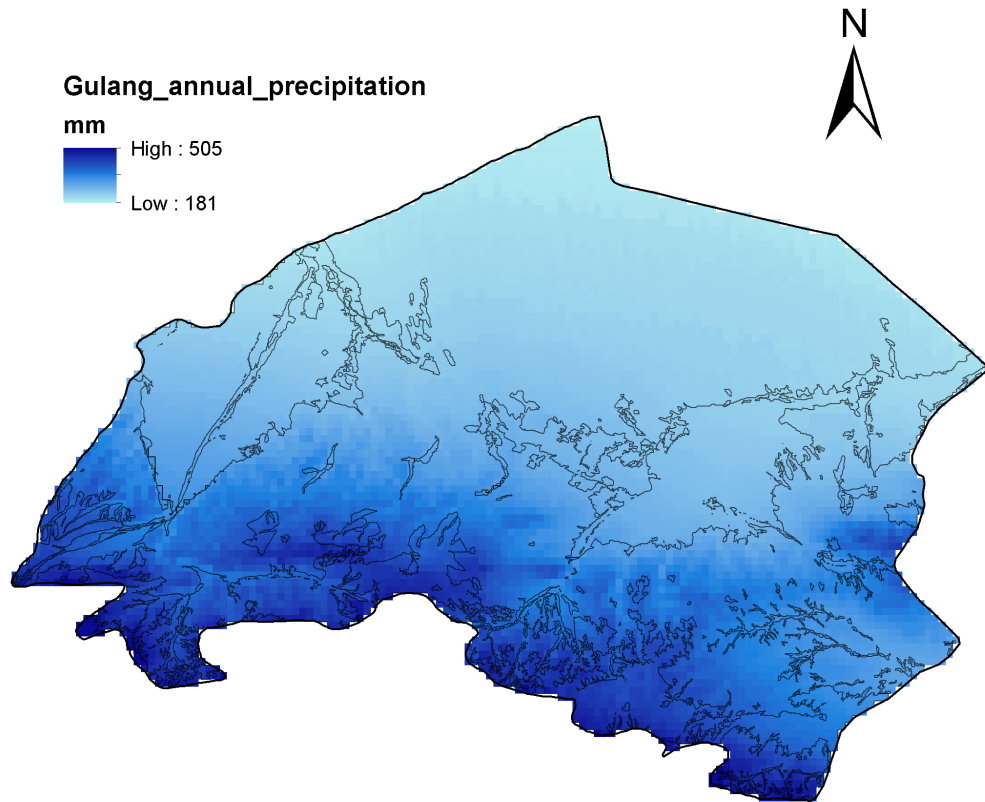




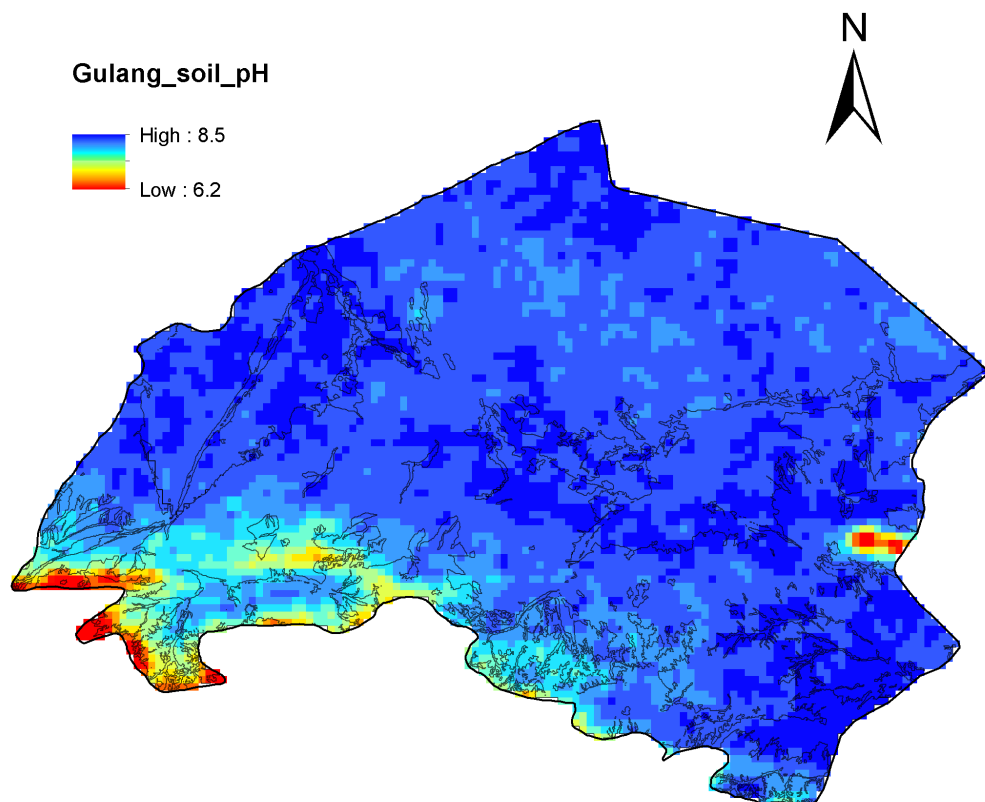
**Figure A2:** Average minimum temperature during growing season in Gulang County croplands.



**Figure A3:** Average maximum temperature during growing season in Gulang County croplands.



**Figure A4:** Average annual precipitation in Gulang County.



**Figure A5:** Soil pH in Gulang County.

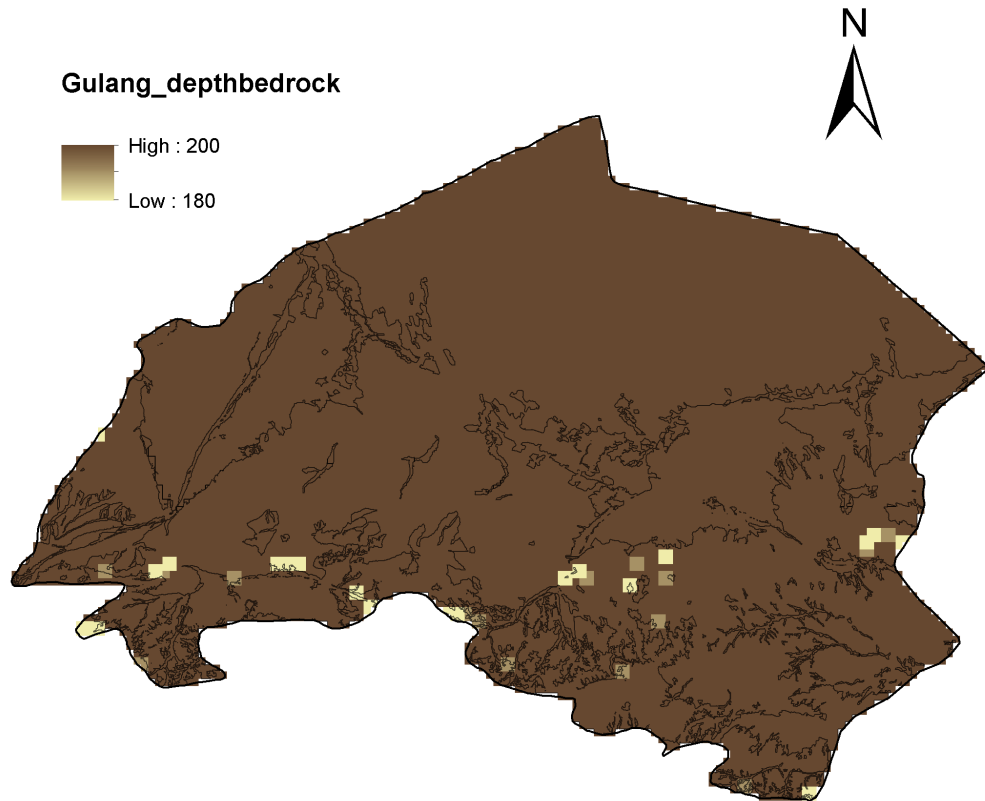


Figure A6: Soil depth to bedrock (cm) in Gulang County.

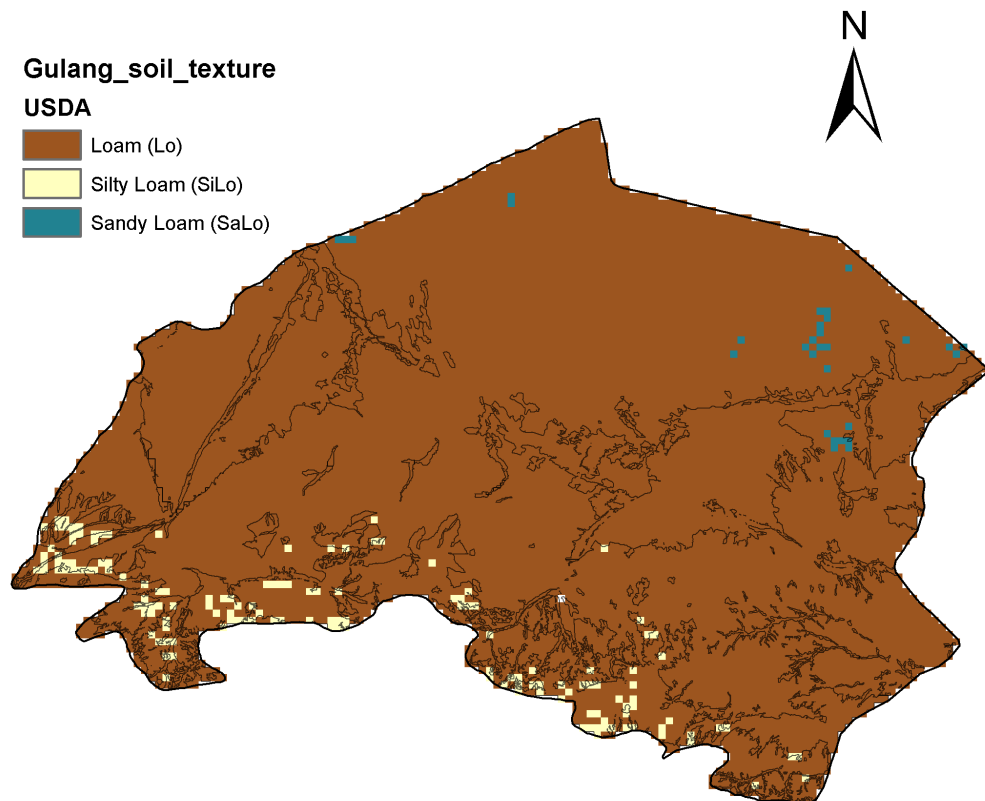


Figure A7: Soil texture (USDA) in Gulang County.

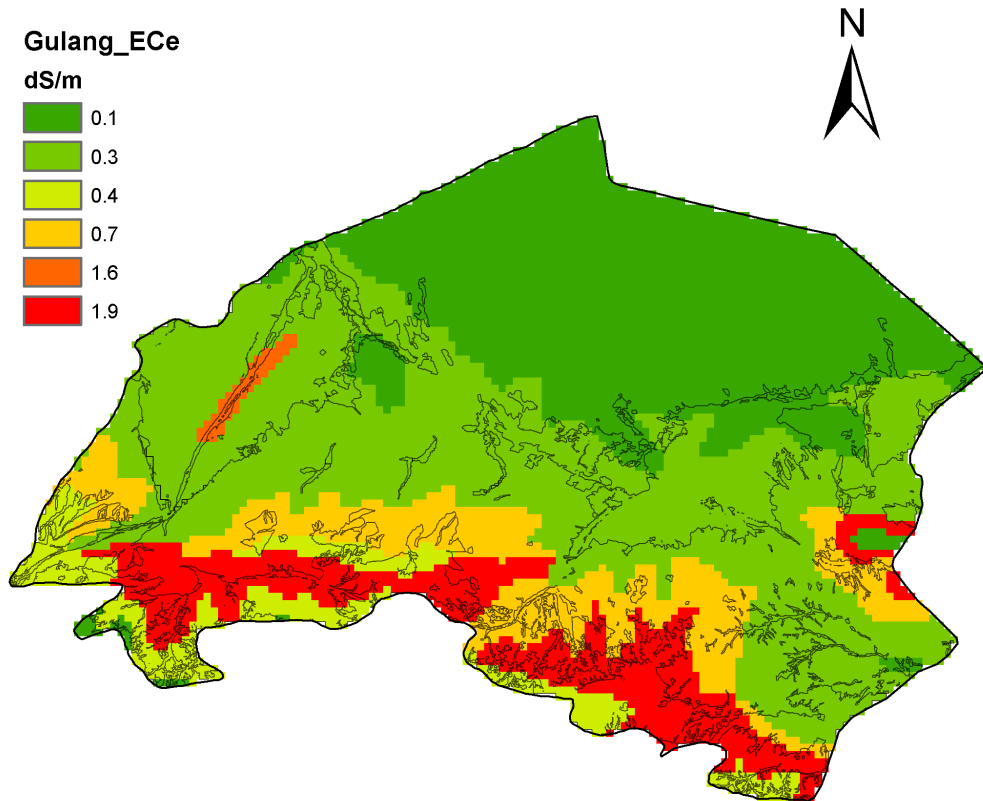


Figure A8: Soil salinity ECe (dS/m) in Gulang County.

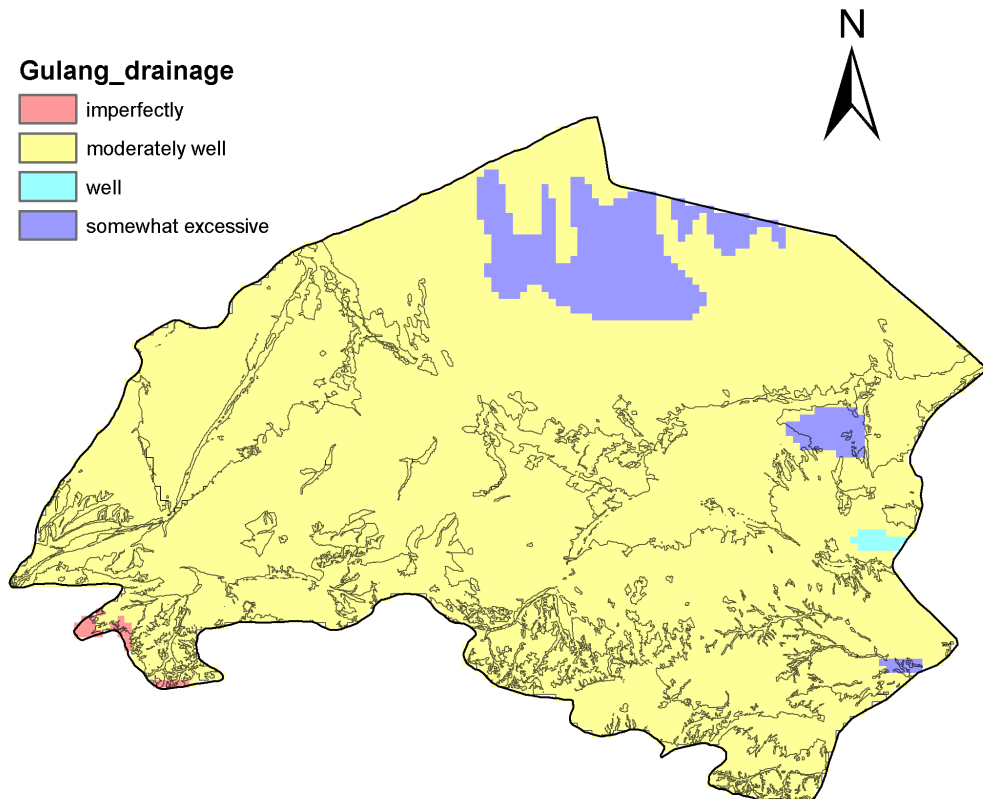


Figure A9: Soil drainage class in Gulang County.

**Table A1:** List of crops identified by search 1 (see Table 5) for open fields, rainfed or irrigated, in lower and higher cropland areas. High potential crops are highlighted in dark green, moderate potential crops in light green and low potential crops in white.

	lower croplands		higher croplands		remark
	rainfed	irrigated	rainfed	irrigated	
<i>Amaranthus caudatus</i>		x			food, proteins, Gartenfuchsschwanz
<i>Apocynum cannabinum</i>	x	x			<i>Apocynum venetum</i> (herbal tea, China)
<i>Atriplex confertifolia</i>	x				forage plant
<i>Bouteloua gracilis</i>		x			grass
<i>Brassica oleracea</i> var. <i>Botrytis</i>		x			cauliflower, food
<i>Brassica oleracea</i> var. <i>Italica</i>		x			broccoli, food
<i>Cenchrus ciliaris</i>		x			grass
<i>Chenopodium quinoa</i>		x	x	x	quinoa, food
<i>Cicer arietinum</i>		x			chickpea, food
<i>Cichorium endivia</i>		x			endive, salad, food
<i>Cucumis sativus</i>		x			cucumber, food
<i>Daucus carota</i>		x		x	wild carrot
<i>Elaeagnus angustifolia</i>			x		Russian olive, food, Norouz (Persian festival)
<i>Eragrostis curvula</i>		x			grass
<i>Gleditsia triacanthos</i>		x			timber, furniture
<i>Haloxylon aphyllum</i>	x				desertification protection, fuel wood
<i>Lolium perenne</i>		x			perennial ryegrass
<i>Lotus uliginosus</i>		x			fodder, pasture
<i>Medicago sativa</i>		x		x	alfalfa, green manure, forage crop
<i>Phaseolus vulgaris</i>		x			common bean, Stangenbohne
<i>Phragmites communis</i>			x		common reed, vegetable, insolation
<i>Pinus brutia</i>		x			Turkish pine
<i>Prosopis tamarugo</i>	x				fuel wood, fodder fruit for sheep and goat
<i>Ruta graveolens</i>		x			herb, Ethiopian cuisine, Weinraute
<i>Solanum nigrum</i>		x			black nightshade
<i>Solanum tuberosum</i>		x			potato
<i>Sorghum bicolor</i> var. <i>Sweet</i>		x			broom-corn sorghum, sweet sorghum
<i>Sporobolus airoides</i>		x			grass
<i>Stipa</i> sp.	x	x			grasses, fodder
<i>Triticum aestivum</i>		x	x	x	bread wheat
<i>Vicia fabia</i>		x	x	x	broad bean, faba bean, Ackerbohne

**Table A2:** List of crops identified by search 2 (see Table 5) for open fields, rainfed or irrigated, in lower and higher cropland areas. High potential crops are highlighted in dark green, moderate potential crops in light green and low potential crops in white.

	lower croplands		higher croplands		remark
	rainfed	irrigated	rainfed	irrigated	
Acacia sp.	x	x	x	x	windbreak, fodder, fuel, erosion control
<b>Aegle marmelos</b>		x			<b>bel fruit, bengalische Quitte</b>
Achnatherum splendens			x		Chinese forage grass
Agropyron sp.	x	x	x	x	grasses
Allium fistulosum		x		x	Spanish onion, Winterzwiebel
Allium sativum		x			garlic
Alopecurus pratensis		x	x	x	grass, Wiesenfuchsschwanz
<b>Amaranthus sp.</b>	x	x			<b>food, fibre, various uses</b>
<b>Amaranthus caudatus</b>		x			<b>food, proteins, Gartenfuchsschwanz</b>
<b>Anacardium occidentale</b>		x			<b>cashew</b>
<b>Apios americana</b>		x			<b>American groundnut, potato bean</b>
<b>Apocynum cannabinum</b>	x	x	x	x	<b>Apocynum venetum (herbal tea, China)</b>
Aristida sp.	x		x		grasses
Armoracia rusticana		x		x	horseradish
Arundinella hirta	x	x	x	x	grass
Atalaya hemiglauca	x				tree gum, food
Atriplex sp.	x		x		forage plant
Bouteloua gracilis		x	x	x	grass
Brassica oleracea var. Botrytis		x		x	cauliflower, food
Brassica oleracea var. Gongyloides		x		x	Kohlrabi, food
Brassica oleracea var. Italica		x		x	broccoli, food
Calamagrostis epigeios		x	x	x	grass
Cenchrus ciliaris		x	x	x	grass
<b>Chenopodium ambrosioides</b>		x	x	x	<b>Mexican tea</b>
<b>Chenopodium pallidicaule</b>		x	x	x	<b>close to quinoa</b>
<b>Chenopodium quinoa</b>		x	x	x	<b>quinoa, food</b>
Chloris gayana		x		x	grass
<b>Cicer arietinum</b>		x			<b>chickpea, food</b>
Cichorium endivia		x	x	x	endivie, salad, food
Cleistogenes squarrosa	x		x		grass
Crotalaria juncea	x	x			sun hemp, green manure, foddre, fibre
Cucumis sativus		x		x	cucumber, food
Cucurbita foetidissima		x	x	x	buffalo gourd, Kürbisgewächse
Cupressus arizonica			x		Arizona cypress
Cynodon dactylon		x			grass
Dalbergia sissoo		x	x	x	Indian rosewood
Daucus carota		x		x	wild carrot
Deyeuxia angustifolia		x	x		grass
Dichanthium annulatum		x			grass
Dodonaea viscosa	x	x			wood, red dye, ornamental
<b>Elaeagnus angustifolia</b>			x		<b>Russian olive, food, Norouz (Persian festival)</b>
Eleusine indica		x			grass
Eragrostis sp.	x	x			grass
Eruca sativa		x			rucola, rocket salad
Eucalyptus sp.	x	x	x	x	various uses
Festuca sp.		x	x	x	grass

Table A2: continued

<i>Ficus carica</i>		x	x	x	common fig
<i>Gleditsia triacanthos</i>		x			timber, furniture
<i>Haloxylon aphyllum</i>	x				desertification protection, fuel wood
<i>Hagenia abyssinica</i>		x		x	kosso tree
<i>Hedysarum coronarium</i>		x		x	fabaceae
<i>Hordeum brevisubulatum</i>		x	x		grass
<i>Indigofera tinctoria</i>		x			indigo, dye
<i>Juniperus procera</i>		x			Afrikanischer Wacholder, juniper, cedar
<i>Koeleria cristata</i>			x	x	grass
<i>Lasiurus hirsutus</i>	x				grass
<i>Lepidium meyenii</i>		x			maca, Peru ginseng
<i>Liquidambar styraciflua</i>		x			gum tree, wood
<i>Lolium perenne</i>		x			perennial ryegrass
<i>Lotus uliginosus</i>		x		x	fodder, pasture
<i>Mangifera indica</i>		x			mango
<i>Medicago sp.</i>		x	x	x	alfalfa, green manure, forage crop
<i>Melilotus sp.</i>		x	x	x	clover
<i>Moringa oleifera</i>		x			horseradish tree, moringa
<i>Origanum vulgare</i>		x			oregano
<i>Panicum maximum</i>		x			grass
<i>Parthenium argentatum</i>		x			guayule, Gummibaum
<i>Phaseolus vulgaris</i>		x			common bean, Stangenbohne
<i>Phragmites communis</i>			x		common reed, vegetable, insolation
<i>Pinus sp.</i>		x		x	Turkish pine
<i>Prosopis sp.</i>	x	x	x		fuel wood, fodder fruit for sheep and goat
<i>Puccinellia tenuiflora</i>			x		grass
<i>Punica granatum</i>		x			pomegranate, grenadine, Chinese apple
<i>Rosmarinus officinalis</i>		x			rosemary
<i>Ruta graveolens</i>		x	x	x	herb, Ethiopian cuisine, Weinraute
<i>Santalum acuminatum</i>	x		x		desert peach (Australia), quandong, food, various uses
<i>Schinus molle</i>			x		pepper tree, Peruanischer Pfeffer, food
<i>Secale montanum</i>			x		grass
<i>Sinapis alba</i>		x		x	white mustard
<i>Solanum nigrum</i>		x			black nightshade
<i>Solanum tuberosum</i>		x			potato
<i>Sorghum bicolor var. Sweet</i>		x			broom-corn sorghum, sweet sorghum
<i>Sporobolus airoides</i>		x		x	grass
<i>Stipa sp.</i>	x	x	x	x	grasses, fodder
<i>Tamarix sp.</i>	x	x	x		windbreak, shade tree
<i>Trifolium fragiferum</i>		x		x	clover
<i>Triticum aestivum</i>		x	x	x	bread wheat
<i>Vicia fabia</i>		x	x	x	broad bean, faba bean, Ackerbohne
<i>Zea mexicana</i>		x		x	teosinte

**Table A3:** List of crops identified by search 3 (see Table 5) not already included in Tables 6 and 7 for open fields, rainfed or irrigated, in lower and higher cropland areas. High potential crops are highlighted in dark green, moderate potential crops in light green and low potential crops in white.

	lower croplands		higher croplands		remark
	rainfed	irrigated	rainfed	irrigated	
<i>Actinidia chinensis</i>		x			Chinese gooseberry, Kiwifruit
<i>Aesculus indica</i>		x			Indian chestnut
<i>Allium ampeloprasum</i>		x		x	wild leek
<i>Allium chinese</i>		x			perennial Chinese onion
<i>Allium schoenoprasum</i>		x	x	x	chives, Schnittlauch
<i>Allium tuberosum</i>		x	x	x	Chinese chives
<i>Anethum graveolens</i>		x		x	dill
<i>Annona reticulata</i>		x			custard apple, sugar apple
<i>Anthemis nobilis</i>		x			Roman chamomile
<i>Anthriscus cerefolium</i>		x		x	chervil, kerbel
<i>Apium graveolens var. Dulce</i>		x	x	x	celery
<i>Artemisia dracunculus</i>		x	x	x	estragon
<i>Asparagus officinalis</i>		x			asparagus
<i>Avena sativa</i>			x	x	oat, Hafer
<i>Beta vulgaris</i>		x			beetroot
<i>Beta vulgaris var. Cicla</i>		x		x	silver beet
<i>Borago officinalis</i>		x	x	x	borage, borretsch
<i>Brassica campestris</i>		x		x	wild turnip
<i>Brassica chinensis</i>		x			Chinese cabbake, pak choi
<i>Brassica juncea</i>		x			Indian mustard
<i>Brassica napus</i>		x		x	rapeseed, canola
<i>Brassica nigra</i>		x	x	x	black mustard
<i>Brassica oleracea var. Acephala</i>		x			curly kale
<i>Brassica oleracea var. Capitata</i>		x			white cabbage, red cabbage, Kraut
<i>Brassica oleracea var. Gemmifera</i>		x			Brussel sprouts, Rosenkohl
<i>Calendula officinalis</i>		x			marigold, Ringelblume
<i>Callitris preissii</i>			x		cypress sp.
<i>Cannabis sativa subsp. Indica</i>		x		x	hemp, Hanf
<i>Capsicum annum</i>		x			sweet pepper, Paprika, Peperoni
<i>Caragana sp.</i>	x		x		shrubs, fabaceae
<i>Carthamus tinctorius</i>		x	x	x	safflower
<i>Carya illioensis</i>		x		x	pecan
<i>Castanea sativa</i>		x			chestnut, Edelkastanie
<i>Catha edulis</i>		x			khat
<i>Chenopodium album</i>		x	x	x	pigweed
<i>Chrysanthemum coronarium</i>		x			crown daisy, food, Asian cuisine
<i>Cichorium intybus</i>		x	x	x	chicory, chicoree
<i>Colocasia esculenta var. Ant.</i>				x	taro, root vegetable, edible corms
<i>Coriandrum sativum</i>		x	x	x	coriander, Chinese parsley
<i>Corylus avellana</i>		x		x	hazel nut, Haselnuss
<i>Crambe maritima</i>		x		x	sea kale
<i>Crocus sativus</i>		x			saffron
<i>Cucumis anguria</i>		x			gherkin, maroon cucumber
<i>Cucurbita ficifolia</i>		x	x	x	fig-leaved gourd
<i>Cucurbita pepo</i>		x	x	x	pumpkin, Gartenkürbis
<i>Cydonia oblonga</i>		x			quince
<i>Cynara scolymus</i>		x			artichoke
<i>Cyperus esculentus</i>		x	x	x	tiger nut
<i>Dimocarpus longan var. Long</i>		x			longan
<i>Diospyros kaki</i>		x			kaki, persimmon, Chinese persimmon
<i>Eleusine africana</i>	x				wild African finger millet
<i>Eleusine coracana subsp. Coracana</i>		x			finger millet
<i>Eragrostis tef</i>		x	x	x	tef
<i>Eugenia jambos</i>		x			roseapple
<i>Fagopyrum seculentum</i>		x			buckwheat, Buchweizen
<i>Fagopyrum tataricum</i>		x		x	India wheat, Iceland buckwheat, cultivated in China
<i>Foeniculum vulgare</i>		x	x	x	fennel
<i>Fragaria chiloensis</i>		x		x	Chilean strawberry
<i>Fragaria vesca</i>		x			wild strawberry, Walderdbeere
<i>Fragaria virginiana</i>		x		x	Virginia strawberry
<i>Fragaria x ananassa</i>		x			strawberry
<i>Frangula alnus</i>		x			buckthorn, Faulbaum
<i>Genista tinctoria</i>				x	fabaceae, dye, medicine
<i>Glycyrrhiza glabra</i>		x	x	x	liquorice, Süssholz
<i>Helianthus annuus</i>		x	x	x	sunflower
<i>Helianthus tuberosus</i>		x			Jerusalem artichoke
<i>Hippophae rhamnoides</i>	x		x		sea buckthorn, Sanddorn, China ( <i>Hippophae goniocarpa</i> )
<i>Hippophae salicifolia</i>	x		x		sea buckthorn, Himalaya
<i>Hordeum vulgare</i>	x	x	x	x	barley



Table A3: continued

Humulus lupulus	x			hop, Hopfen
Junglans nigra		x	x	Eastern black walnut
Juglans regia	x			walnut, Nussbaum, Walnuss
Junglans sieboldiana			x	Japanese walnut
Lablab purpureus	x	x	x	lablab bean, field bean
Lactuca sativa var capitata			x	lettuce
Lathyrus cicera		x		chickling vetch, falcon pea
Lathyrus hirsutus	x		x	caley pea
Lathyrus ochrus		x		
Lathyrus sativus	x		x	grass pea, Indian vetch
Laurus nobilis	x			bay leaves, Lorbeer
Lavandula angustifolia	x			true lavender, Lavendel
Lens culinaris	x	x	x	lentil
Lepidium sativum	x		x	creess, Kresse
Lesquerella fendleri	x			bladderpod, oil, desert mustard
Levisticum officinalis	x		x	lovage, Liebstöckl
Linum usitatissimum	x	x	x	flax, linseed
Lupinus sp.	x		x	lupin, Lupine
Lycium chinese	x			Goji, boxthorn
Lycopersicon esculentum	x			tomato
Malus domestica	x			apple
Marrubium vulgare	x			horehound, Andorn
Melaleuca quinquenervia	x			paperbark tree, various uses, Australia
Melia azedarach	x			Chinaberry, China tree, wood
Melissa officinalis			x	balm, melisse, Melisse, Zitronenmelisse
Mentha sp.	x	x	x	peppermint, spearmint
Mirabilis expansa	x			mauka, yuca, root vegetable, Andean
Murraya koenigii	x			curry leaves
Nasturtium officinale	x	x	x	watercress
Nepata cataria	x		x	catnip, Katzenminze
Nicotiana tabacum	x			tobacco
Nigella sativa	x		x	fennel-flower, black cumin, Schwarzkümmel
Ocimum basilicum	x			basil, Basilikum
Onobrychis sp.		x	x	sainfoins, Esparsette, fabaceae
Origanum onites			x	Turkish oregano
Oxalis tuberosa	x			oca, Knollen-Sauerklee
Papaver somniferum	x	x	x	poppy, opium, Mohn, Schlafmohn
Parkia biglobosa	x			African locust bean
Passiflora mollissima	x			banana
Pastinaca sativa	x	x	x	parsnip, Pastinake
Petroselinum crispum	x			parsley, Petersilie
Phaseolus sp.	x		x	beans
Phytolacca acinosa	x			Asian poke weed, edible pokeweed
Pimpinella anisum	x		x	anise, Anis
Pisum sativum	x		x	pea, garden pea, Erbse
Polymnia sonchifolia	x			yacon, Peruvian ground apple, Andean root vegetable
Prunus armeniaca	x			apricot, Aprikose
Prunus sp.	x			sweet cherry, sour cherry, plums
Pyrus pyrifolia	x			Chinese pear, Nashi
Raphanus sativus	x		x	small radish
Rheum rhaponticum	x		x	rhubarb, Rhabarber
Ribes sp.	x		x	black currant, red current, gooseberry, Johannisbeeren, Stachelbeeren
Rubus sp.	x	x	x	rasperry, black rasperry, dewberry, Himbeere
Salvia officinalis	x	x	x	sage, salvia, Salbei
Sambucus canadensis	x	x	x	common elder, Holunder
Secale cereale	x		x	rye, Roggen
Setaria italica	x	x		foxtail millet, Kolbenhirse
Spinacia oleracea	x	x	x	spinach
Taraxacum officinale	x	x	x	dandelion, Löwenzahn
Tarchonathus camphoratus	x			cahphor bush, fragrant wood, fuel
Terminalia chebula			x	dye, fruit, food, Ayurveda
Thymus sp.	x		x	thyme
Tragopogon porrifolius	x		x	salsify, Haferwurz
Trifolium sp.	x	x	x	clover
Trigonella foenumgraecum	x		x	fenugreek, Bockshornklee
Triticum spelta	x	x	x	spelt wheat
Tropaeolum tuberosum	x			mashua, mashwa, tuber vegetable, Peru, Ecuador
Ullucus tuberosus	x		x	ulluco, root vegetable, South America
Vaccinium sp.	x		x	blueberry, cranberry, Moosbeere, Blaubeere
Valeriana officinalis	x		x	valerian, Baldrian
Vicia sp.	x	x	x	vetch
Vigna sp.	x		x	bean, black gram, green gram
Vitis labrusca	x		x	fox grape, plum grape

**Table A4:** List of crops identified by search 2\_2 (see Table 5) for greenhouse conditions in lower and higher cropland areas. High potential crops are highlighted in dark green, moderate potential crops in light green and low potential crops in white.

	lower croplands greenhouse	higher croplands greenhouse	remark
Acacia sp.	x	x	windbreak, fodder, fuel, erosion control
Aegle marmelos	x	x	bel fruit, bengalische Quitte
Allium sativum	x	x	garlic
Amaranthus sp.	x	x	food, fibre, various uses
Amaranthus caudatus	x	x	food, proteins, Gartenfuchschschwanz
Anacardium occidentale	x	x	cashew
Apocynum cannabinum	x	x	Apocynum venetum (herbal tea, China)
Atalaya hemiglauca	x	x	tree gum, food
Averrhoa carambola	x	x	five corner, carambola, star fruit
Brassica oleracea var. Botrytis	x	x	cauliflower, food
Brassica oleracea var. Italica	x	x	broccoli, food
Chenopodium ambrosioides	x	x	Mexican tea
Chenopodium quinoa	x	x	quinoa, food
Cicer arietinum	x	x	chickpea, food
Cichorium endivia	x	x	endivie, salad, food
Crotalaria juncea	x		sun hemp, green manure, foddre, fibre
Cucumis sativus	x	x	cucumber, food
Cucurbita foetidissima	x	x	buffalo gourd, Kürbisgewächse
Dalbergia sissoo	x	x	Indian rosewood
Daucus carota	x	x	wild carrot
Dodonaea viscosa	x	x	wood, red dye, ornamental
Elaeagnus angustifolia	x	x	Russian olive, food, Norouz (Persian festival)
Eucalyptus sp.	x	x	various uses
Ficus carica	x	x	common fig
Gleditsia triacanthos	x	x	timber, furniture
Hagenia abyssinica	x	x	kosso tree
Hedysarum coronarium	x	x	fabaceae
Juniperus procera	x	x	Afrikanischer Wacholder, juniper, cedar
Mangifera indica	x	x	mango
Medicago sp.	x	x	alfalfa, green manure, forage crop
Moringa oleifera	x	x	horseradish tree, moringa
Origanum vulgare	x	x	oregano
Parthenium argentatum	x	x	guayule, Gummibaum
Phaseolus vulgaris	x	x	common bean, Stangenbohne
Phragmites communis	x	x	common reed, vegetable, insolation
Punica granatum	x	x	pomegranate, grenadine, Chinese apple
Rosmarinus officinalis	x	x	rosemary
Ruta graveolens	x	x	herb, Ethiopian cuisine, Weinraute
Schinus molle	x	x	pepper tree, Peruanischer Pfeffer, food
Sinapis alba	x	x	white mustard
Solanum nigrum	x	x	black nightshade
Solanum tuberosum	x	x	potato
Sorghum bicolor var. Sweet	x	x	broom-corn sorghum, sweet sorghum
Tamarix sp.	x	x	windbreak, shade tree
Triticum durum	x	x	durum wheat
Vicia fabia	x	x	broad bean, faba bean, Ackerbohne
Ziziphus mucronata	x	x	buffalo thorn

**Table A5:** List of crops identified by search 3\_2 (see Table 5) for greenhouse conditions in lower and higher cropland areas. High potential crops are highlighted in dark green, moderate potential crops in light green and low potential crops in white.

	lower & higher croplands greenhouse	remark
Acacia sp.	x	windbreak, fodder, fuel, erosion control
Aegle marmelos	x	bel fruit, bengalische Quitte
Allium sativum	x	garlic
Allium schoenoprasum	x	chives, Schnittlauch
Allium tuberosum	x	Chinese chives
Amaranthus sp.	x	food, fibre, various uses
Amaranthus caudatus	x	food, proteins, Gartenfuchsschwanz
Amaranthus tricolor	x	amaranth
Anacardium occidentale	x	cashew
Annona cherimola	x	cherimoya, Sauerapfel
Annona reticulata	x	custard apple, sugar apple
Anthemis nobilis	x	Roman chamomile
Apocynum cannabinum	x	Apocynum venetum (herbal tea, China)
Asparagus officinalis	x	asparagus
Atalaya hemiglauc	x	tree gum, food
Avena sativa	x	oat, Hafer
Averrhoa carambola	x	five corner, carambola, star fruit
Beta vulgaris	x	beetroot
Beta vulgaris var. Cicla	x	silver beet
Beta vulgaris var. Crassa	x	fodder crop
Bombex ceiba	x	wood, ornamental
Boswellia serrata	x	frankincense, olibanum, Weihrauch
Brassica campestris	x	wild turnip
Brassica chinensis	x	Chinese cabbake, pak choi
Brassica juncea	x	Indian mustard
Brassica napus	x	rapeseed, canola
Brassica oleracea var. Acephala	x	curly kale
Brassica oleracea var. Botrytis	x	cauliflower, food
Brassica oleracea var. Capitata	x	white cabbage, red cabbage, Kraut
Brassica oleracea var. Italica	x	broccoli, food
Calendula officinalis	x	marigold, Ringelblume
Cannabis sativa subsp. Indica	x	hemp, Hanf
Capsicum annuum	x	sweet pepper, Paprika, Peperoni
Caragana sp.	x	shrubs, fabaceae
Carthamus tinctorius	x	safflower
Carya illioensis	x	pecan
Cassia sp.	x	senna, golden shower
Castanea sativa	x	chestnut, Edelkastanie
Catha edulis	x	khat
Chenopodium album	x	pigweed
Chenopodium ambrosioides	x	Mexican tea
Chenopodium quinoa	x	quinoa, food
Cicer arietinum	x	chickpea, food
Cichorium endivia	x	endivie, salad, food
Cichorium intybus	x	chicory, chicoree
Coriandrum sativum	x	coriander, Chinese parsley
Corylus avellana	x	hazel nut, Haselnuss
Crotalaria juncea	x	sun hemp, green manure, foddre, fibre

**Table A5:** Continued (1)

<i>Cucumis anguria</i>	x	gherkin, maroon cucumber
<i>Cucumis sativus</i>	x	cucumber, food
<i>Cucurbita ficifolia</i>	x	fig-leaved gourd
<i>Cucurbita foetidissima</i>	x	buffalo gourd, Kürbisgewächse
<i>Cucurbita pepo</i>	x	pumpkin, Gartenkürbis
<i>Cydonia oblonga</i>	x	quince
<i>Cynara scolymus</i>	x	artichoke
<i>Cyperus esculentus</i>	x	tiger nut
<i>Dalbergia sissoo</i>	x	Indian rosewood
<i>Daucus carota</i>	x	wild carrot
<i>Diospyros kaki</i>	x	kaki, persimmon, Chinese persimmon
<i>Dodonaea viscosa</i>	x	wood, red dye, ornamental
<i>Elaeagnus angustifolia</i>	x	Russian olive, food, Norouz (Persian festival)
<i>Eleusine africana</i>	x	wild African finger millet
<i>Eleusine coracana</i> subsp. <i>Coracana</i>	x	finger millet
<i>Eragrostis tef</i>	x	tef
<i>Eucalyptus</i> sp.	x	various uses
<i>Fagopyrum esculentum</i>	x	buckwheat, Buchweizen
<i>Fagopyrum tataricum</i>	x	India wheat, Iceland buckwheat, cultivated in China
<i>Ficus carica</i>	x	common fig
<i>Foeniculum vulgare</i>	x	fennel
<i>Gleditsia triacanthos</i>	x	timber, furniture
<i>Glycyrrhiza glabra</i>	x	liquorice, Süssholz
<i>Hagenia abyssinica</i>	x	kosso tree
<i>Hedysarum</i> sp.	x	fabaceae
<i>Helianthus annuus</i>	x	sunflower
<i>Helianthus tuberosus</i>	x	Jerusalem artichoke
<i>Hippophae rhamnoides</i>	x	sea buckthorn, Sanddorn, China ( <i>Hippophae goniocarpa</i> )
<i>Hordeum vulgare</i>	x	barley
<i>Humulus lupulus</i>	x	hop, Hopfen
<i>Jatropha curcas</i>	x	physic nut, tartago
<i>Juglans nigra</i>	x	Eastern black walnut
<i>Juglans regia</i>	x	walnut, Nussbaum, Walnuss
<i>Juglans sieboldiana</i>	x	Japanese walnut
<i>Juniperus procera</i>	x	Afrikanischer Wacholder, juniper, cedar
<i>Lablab purpureus</i>	x	lablab bean, field bean
<i>Lathyrus hirsutus</i>	x	caley pea
<i>Lathyrus sativus</i>	x	grass pea, Indian vetch
<i>Laurus nobilis</i>	x	bay leaves, Lorbeer
<i>Lens culinaris</i>	x	lentil
<i>Linum usitatissimum</i>	x	flax, linseed
<i>Lotus</i> sp.	x	Fabaceae
<i>Lupinus</i> sp.	x	lupin, Lupine
<i>Lycium chinese</i>	x	Goji, boxthorn
<i>Lycopersicon esculentum</i>	x	tomato
<i>Malus domestica</i>	x	apple
<i>Mangifera indica</i>	x	mango
<i>Marrubium vulgare</i>	x	horehound, Andorn
<i>Matricaria recutita</i>	x	German chamomile, Kamille
<i>Medicago</i> sp.	x	alfalfa, green manure, forage crop
<i>Melia azedarach</i>	x	Chinaberry, China tree, wood

**Table A5:** Continued (2)

Melissa officinalis	x	balm, melisse, Melisse, Zitronenmelisse
Mentha sp.	x	peppermint, spearmint
Moringa oleifera	x	horseradish tree, moringa
Murraya koenigii	x	curry leaves
Nasturtium officinale	x	watercress
Nicotiana tabacum	x	tobacco
Nigella sativa	x	fennel-flower, black cumin, Schwarzkümmel
Ocimum basilicum	x	basil, Basilikum
Olea cuspidata	x	Indian olive
Onobrychis sp.	x	sainfoins, Esparsette, fabaceae
Origanum vulgare	x	oregano
Parkia biglobosa	x	African locust bean
Parthenium argentatum	x	guayule, Gummibaum
Phaseolus sp.	x	beans
Phragmites communis	x	common reed, vegetable, insolation
Pimpinella anisum	x	anise, Anis
Pisum sativum	x	pea, garden pea, Erbse
Polymnia sonchifolia	x	yacon, Peruvian ground apple, Andean root vegetable
Portulaca oleracea	x	purslane, pigweed
Prosopis sp.	x	fuel wood, fodder fruit for sheep and goat
Prunus sp.	x	sweet cherry, sour cherry, plums
Punica granatum	x	pomegranate, grenadine, Chinese apple
Pyrus pyrifolia	x	Chinese pear, Nashi
Raphanus sativus	x	small radish
Rhamnus prinoides	x	dogwood, Ethiopian beer
Rheum rhaponticum	x	rhubarb, Rhubarber
Ribes sp.	x	black currant, red current, gooseberry, Johannisbeeren, Stachelbeeren
Rosmarinus officinalis	x	rosemary
Ruta graveolens	x	herb, Ethiopian cuisine, Weinraute
Salvia officinalis	x	sage, Salbei, salvia
Sauropus androgynus	x	katuk, star gooseberry, sweet leaf, leaf vegetable
Schinus molle	x	pepper tree, Peruanischer Pfeffer, food
Secale cereale	x	rye, Roggen
Setaria italica	x	foxtail millet, Kolbenhirse
Sinapis alba	x	white mustard
Solanum nigrum	x	black nightshade
Solanum tuberosum	x	potato
Sorghum bicolor var. Sweet	x	broom-corn sorghum, sweet sorghum
Tamarix sp.	x	windbreak, shade tree
Tarhonathus camphoratus	x	cahphor bush, fragrant wood, fuel
Thymus sp.	x	thyme
Trifolium sp.	x	clover
Trigonella foenumgraecum	x	fenugreek, Bockshornklee
Triticum durum	x	durum wheat
Vaccinium sp.	x	blueberry, cranberry, Moosbeere, Blaubeere
Valeriana officinalis	x	valerian, Baldrian
Vicia sp.	x	broad been, faba bean, Ackerbohne, vetch
Vigna sp.	x	bean, black gram, green gram
Ziziphus mucronata	x	buffalo thorn