RAISE-FS brief # 003

Potential of production expansion of ginger: Suitability map for Ethiopia

Introduction

The diverse agro-ecology in Ethiopia supports the production of a wide variety of spice crops; produced in various regions of the country and predominantly by small holder farmers (Alemnew, 2021). Ginger is one of the major spices in Ethiopia, predominantly cultivated in the South part of the country mainly Southwest Ethiopia (SWE) and Southern Nations Nationalities Peoples (SNNP) regions. However, existing pockets of production areas in the different regions of the country indicate the huge potential to expand its production (Kifile et al, 2023).

Up-to-date and good quality information about land resources and their potential for various uses is thus a prerequisite for appropriate land use planning and answer the question "what to grow where" (FAO, 1993; Mustafar et al., 2011).

Land suitability analysis is an important prerequisite to achieve optimum utilization of the land resources for sustainable agricultural production (Perveen et al., 2007). FAO (1976) defined land suitability as the fitness of a given type of land for a specified kind of land use on a sustained basis. An efficient agricultural production system, requires a proper decision on crop technology targeting for production. In order to determine the most desirable direction for future development, the suitability for various land uses should be carefully studied with the aim of directing growth to the most appropriate areas (Baniya, 2008).

The main objective of this assessment is to document the potential for expanding ginger production

KEY messages

- Ginger is predominantly cultivated in the South part of Ethiopia, mainly in the Southwest Ethiopia and Southern Nations Nationalities Peoples regions. However, evidence indicates that there is huge potential to expand its production to other regions.
- One of the key interventions in the agricultural sector transformation is exploitation of existing potential for high value commodities that can contribute to both domestic consumption as well as export. To exploit this potential, it requires evidence based decision making to which commodity to target and promote.
- To support evidence-based decision making, a suitability map of ginger production in Ethiopia is presented. This informs relevant stakeholders including smallholder and commercial farmers, development partners, and policy makers about the identified potential areas for production expansion.
- Eighteen percent (20.42 million ha) of the total area of the country falls within the highly suitable and the moderately suitable classes for ginger production.
- In terms of regional distribution, Benishangul Gumuz, Oromia, South West Ethiopia Peoples, Southern Nations Nationalities Peoples and Amhara regions have the largest spatial coverage of highly suitable land for the production of ginger using the existing varieties combined with improved agronomic practices.

by identifying locations suitable for production of ginger in the different parts of the country through a land suitability map based on a GIS analysis. This will inform relevant actors in those identified suitable locations to test, validate and scale up ginger production.

Constructing the suitability map

Scope and suitability categories

Climate, soil and topographic factors, which are known to be of importance for specific crop were divided into four corresponding suitability classes: not suitable (N), marginally suitable (S3), moderately suitable (S2) and highly suitable (S1). These criteria were then combined using weighted overlay analyses to generate the overall suitability map.

The analysis was limited to the evaluation of physical factors such as climate, topography, soils and land use/cover. Moreover, this analysis focused only on rain-fed agriculture. It should also be expected that boundaries between suitability classes would need review and revision with time considering improved data availability, technical, economic and social changes (FAO, 1976).

Data used and sources

The main biophysical requirements considered include climate, topography and soil related factors. Administrative boundaries and infrastructure (roads, towns, and other facilities) were used to superimpose with and prepare the final map. Parks, large waterbodies and built-up data layers were used to exclude (restrict) the areas in the land suitability analyses.

The climate data used were long-term rainfall and temperature which were interpolated at a resolution of about 300m, which were resampled, to 200m to match the analyses resolution. Length of Growing Period (LGP) of MoARD (WBISPP, 2004) was used with a slight modification. The soil data used were depth, texture, drainage and pH. The soil properties were extracted from Hengl et al. (2020) and Soilgrids 250m. For the altitude and slope information, Shuttle Radar Topography Mission (SRTM) 90 m Digital Elevation database (Jarvis et al., 2008) was used. Slope map was derived from the SRTM database. These data were resampled to a resolution of 200m to fit the analyses resolution that is 200m.

The environmental requirements of ginger and the suitability class limits (thresholds) for each class of the criteria, were established (defined) through subject matter expert consultation, review of literature (Geta and Kifle, 2011; FAO, 2022; Girma et al., 2002; Girma et al., 2008; Girma and Zena, 2009; Girma et al., 2022; Sharma and Sharma, 2012; Jansen et al., 1981; Kandiannan et al., 1996; MoARD, 2007; Naidu, et al., 2006). For classification of the geospatial data layers according to the degree of favourability for ginger, the information was reviewed and used in defining the ranges/limits of the land suitability for various crops. Based on the collected environmental requirements, the factors were first independently examined and rated.

Mapping methods

The overall land suitability map is the combined result of the altitude, slope, soil properties, and the climate layers. Since the analyses were a raster-based, some of the data in vector format were converted to raster format. The weighted overlay approach was used for overlay analyses to solve such multi-criteria problems of suitability. The purpose of weighting is to express the importance or preference of each parameter relative to other factor effects on crop yield and growth rate (Perveen et al., 2007).

The Multi-Criteria Decision-Making approach for the Analytic Hierarchy Process (AHP) was used to calculate the weights for the different criteria (Saaty, 1987; Chivasa et al., 2019). AHP relies on pairwise comparisons that assign values based on relative importance of criteria layers (see Table 1). The criteria were evaluated, and numerical scales of measurement were derived through comparing against the goal. The pairwise comparison scales were assigned through discussion among experts. These data layers were assigned weights to account for their relative importance in the growth of the crops and combined (overlaid) using weighted overlay to produce the overall land suitability map.

Table 1. The resulting weights for the criteria based on pairwise comparisons

No	criteria	Priority	Rank
1	Organic mater	10.3%	4
2	Soil texture	7.1%	8
3	pH	7.1%	8
4	Depth	6.5%	10
5	Drainage	7.2%	7
6	LGP	8.9%	5
7	Rainfall	16.9%	1
8	Temperature	14.8%	2
9	Digital Elevation Method	14.0%	3
10	Slope (%)	7.2%	6

Results and discussion

The result from the land suitability analyses showed that the highly, moderately and marginally suitable lands for ginger production are 7.44 (6.6 %), 12.98 (11.5%) and 7.21 (6.4%) million hectares, respectively (Figure 1, and Table 2). The results show that areas that fall within the highly suitable and the moderately suitable classes together represent 18.03% (20.42 million ha) of the total area of the country.

In terms of regional distribution, Benishangul Gumuz (BSG), Oromia, South West Ethiopia Peoples (SWEP), Southern Nations Nationalities Peoples (SNNP) and Amhara regions have largest spatial coverage of highly suitable land, with 2.33 (46.2%), 2.09 (6.5%), 1.52 (38.8%), 0.58 (9.2%), 0.53 (3.4%) million hectares in the same order. For moderately suitable classes, Oromia has extensive areas with about 4.44 (13.8%) followed by Amhara, BSG, SNNP and SWEP regions with 2.25 (14.4 %), 2.12 (42.1%), 1.60 (25.3 %) and 1.04 (26.6%) million hectares respectively.

Table 2 presents the summary of suitability for ginger production by region and zone and identified important woredas where ginger can be promoted. In general, considering the highly and moderately suitable classes combined ar-

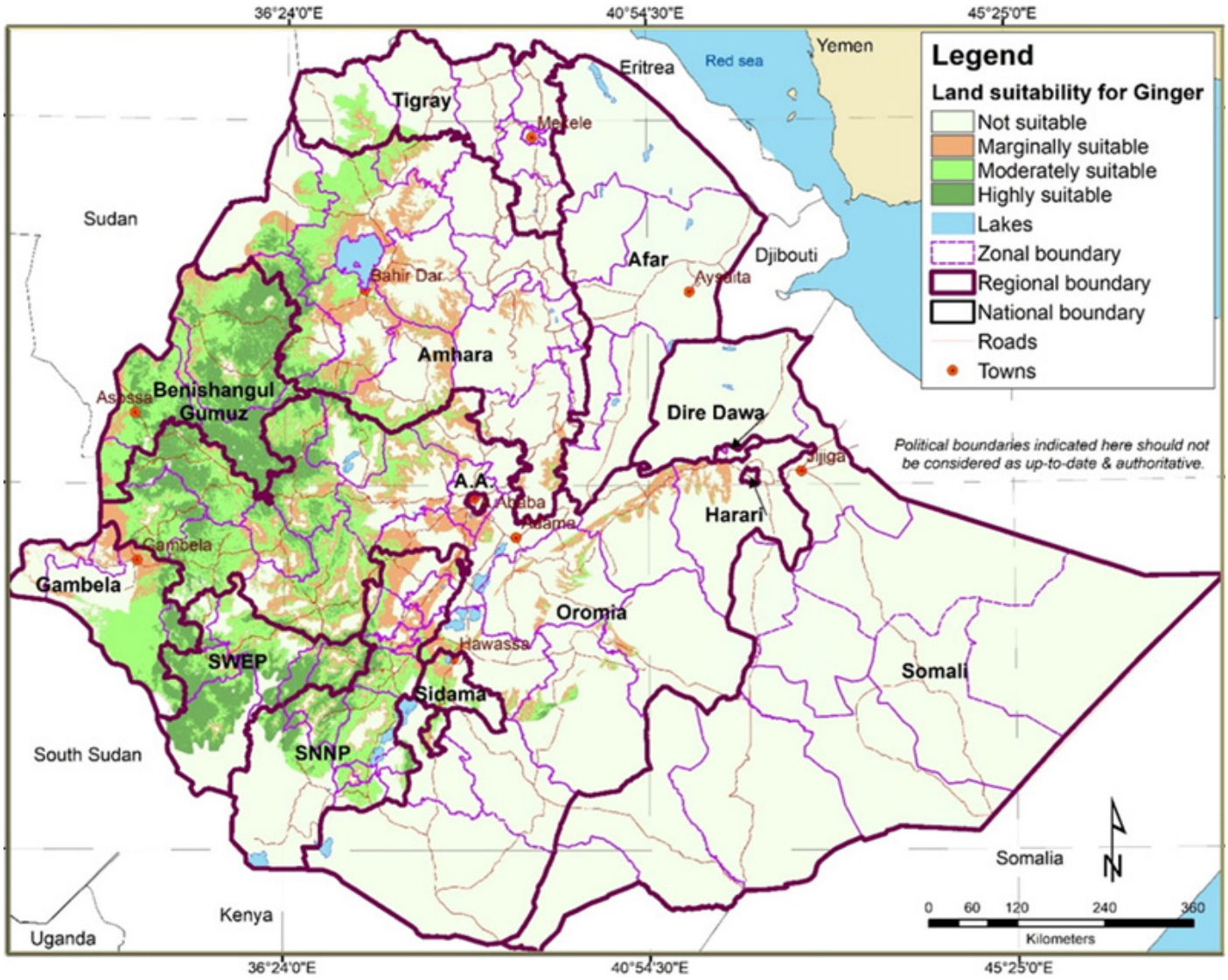

Figure 1 Land suitability map for ginger production

Table 2 Proportion of land under different suitability classes for ginger production by Region and Zone; lists of potential Woredas

Regions	Region		Potential Zones		List of woreda
	Area (ha)	%	Zone	%	
Amhara	529,476	3.40	Awi	30.0	Jawi, Guangua, Ayehu, Guwagusa and Dangila
			West Gojam	9.1	Wemberma, Bure, Debub Achefer, Semen Achefer, Jabi Tehnan, Dembecha, Bahirdar Zuria
			Central Gondar	3.5	Alefa, Takusa and Tach Armacho
			West Gondar	3.4	Quara and Adagn Ager Chaqo
			East Gojam	0.5	Debre Elias and Aneded
BSG	2,326,464	46.17	Kamashi	66.2	Kamashi, Mizyiga,Dembe,Zayi and Sedal
			Metekel	50.4	Pawe, Mandura, Bulen, Dangur, Dibate, Wembera and Guba
			Assosa	30.9	Bilidigilu, Homosha, Kurmuk, Bambasi, Sherkole, Undulu, Menge and Assosa
			Mao Komo Special	3.9	Mao Komo Special
Gambela	382,196	12.16	Majang	71.2	Mengesh and Godere
			Agnewak	9.8	Gambela Zuria, Dima and Abobo
Oromia	2,088,396	6.46	West Wellega	47.0	Guliso, Babo, Mana Sibu, Ayira, Kiltu Kara, Gudetu Kondole, Boji Chekorsa, Jarso (West Wellega), Yubdo, Begi, Homa, Sayo Nole, Leta Sibu, Gaji, Boji Dirmeji, Lalo Asabi, Gimbi, Haru, Nejo and Nole Kaba
			East Wellega	34.0	Guto Gida, Sasiga, Diga, Kiremu, Limu, Wama Hagalo, Haro Limu, Gida Ayana, Nunu Kumba, Leka Dulecha, Bila Seyo, Jimma Arjo, Sibu Sire, Ibantu, Boneya Boshe and Wayu Tuka
			Kelem Wellega	29.6	Lalo Kile, Gawo Kebe, Dale Sadi, Sedi Chenka, Dale Wabera, Jimma Horo, Sayo, Yama Logi Welel, Gidami, Hawa Galan and Anfilo
			Ilu Aba Bora	24.1	Darimu, Bure, Bilo Nopha, Metu Zuria, Ale, Didu, Sale Nono, Halu /Huka and Alge Sachi
			Buno Bedele	19.8	Chwaka, Borecha, Bedele Zuria, Dabo Hana, Dedesa, Meko and Gechi
			Horo Gudru Wellega	17.0	Abe Dongoro, Amuru, Jarte Jardega, Horo Buluk and Abay Chomen
			Jimma	11.0	Shebe Sambo, Limu Seka,Mancho, Omo Beyam, Omo Nada, Nono Benja, Chora , Kersa , Dedo, Goma, Seka Chekorsa, Limu Kosa, Mena and Gumay
			West Shewa	1.1	Bako Tibe, Dano, Illu Galan and Nono
Sidama	8,512	1.26	Sidama	1.3	Aleta Chuko, Dara Otilicho, Dara, Bona Zuria, Bensa, Chabe Gambeltu and Loka Abaya
SNNP	583,188	9.20	Basketo	63.2	Basketo SP Woreda,
			Gofa	41.9	Denba Gofa, Melekoza, Melo Gada, Zala, Uba Debre Tsehay, Gezei Gofa and O'yida
			Amaro	19.2	Amaro
			Wolayita	16.4	Kindo Daddaye, Boloso Bombe, Kindo Koyesha, Bayera Koisha, Kawo Koisha,Damot Sore, Ofa,Boloso Sore,Sodo Zuria,Duguna Fango and Damot Woide
			Kembata Tembaro	12.4	Tembaro and Hadero Tunto
			South Omo	7.4	South Ari, North Ari, Salamago, Wub Ari, Boko Dawula and Malie
			Gamo	5.8	Kucha Alpha, Kucha, Gerese, Kemba, Daramalo, Garda Marta and Boreda
			Hadiya	4.1	Mirab Soro and Soro
			Gedeo	3.5	Dila Zuria, Wenago and Kochere
			Burji	2.6	Burji Special
			Derashe	2.3	Derashe Special
			Alle	1.8	Alle Special
			Konso	1.4	Karat Zuria and Kena
SWEP	1,517,536	38.79	Konta Special	74.3	Konta
			Bench Sheko	51.4	Gurafereda, Debub Bench, Gidi Bench, Sheko, Semen Bench and Shay Bench
			Dawuro	44.8	Gena. Zabagazo, Tercha Zuriya, Isara, Disa, Loma, Kachi, Tocha, Mareka and Mari Mansa
			Mirab Omo	42.7	Bero, Gori Gesha, Menit Goldiye, Menit Shasha, Gachit, Surma and Maji
			Sheka	25.7	Yeki, Masha, Anderacha and Tepi
			Kefa	20.3	Cheta, Goba (SP), Decha, Gewata, Chena, Tullo, Bita, Gimbo, Adiyio and Shisho Ande,

eas Oromia stands first with 6.53 million hect ares followed by BSG, Amhara, SWEP, SNNP and Gambela. In terms of percentage cover of the total areas of respective regions, BSG comes 1st with significantly high proportion (i.e. 88.3%) followed by SWEP (65.3%), Gambela (45.1%), SNNP (34.5 %), Sidama (24.6 %) and Oromia (20.2 %). Hence, in examining the extent of suitability, it not only the area coverage per region, it is also good to consider the total area of the respective regions.

The actual land that can be available for ginger production is obviously lower since it could be already occupied by other land uses. However, this suitability result shows the possibility for expansion to new areas since the current area of production for ginger in the country is, in most cases, mostly confined in the SWEP and SNNP regions (Kifile et al., 2023). The details are presented in Annex I.

As there is diversity within a zone, it is also expected that there will be considerable diversity within each identified woreda i.e. across the different kebeles in each woreda. This implies that there is still a need to further

Conclusions

One of the key interventions in the agricultural sector transformation is exploitation of existing potentials for high value commodities that can contribute to both domestic consumption and export. In this regard, existing potentials are often identified using suitability mapping that helps to assess where a given commodity can be grown successfully.

The results showed that in addition to the predominantly known growing areas (such as SWEP and SNNP), BSG and Gambela regions have high potential for expansion. A significantly large proportion of their land fall under highly and moderately suitable areas of ginger. This suitable land also has a good climate that matches the requirement of ginger production.

Given the presence of knowledge institutes i.e. agricultural research centres and universities in each zone of the country, the testing, validation for scaling of ginger in respective zone is expected to be handled by the knowledge institutes.

In terms of the availability of improved ginger varieties, Jimma Agricultural Research Centre of the Ethiopian Institute of Agricultural Research (EIAR) has released two varieties. These are Yali (Miz.180/73) and Boziab (Mau. 37/79) and both varieties were released in 2007 (MoA, 2019).

The main objective of suitability mapping was to inform relevant stakeholders including smallholder and commercial farmers, development partners, and policy makers about the identified potential areas for ginger production expansion. The production expansion is in turn expected to enhance value addition and ginger-based product development. Accordingly, it is expected that knowledge institutes in respective potential zones for ginger will promote the testing, validation and scaling of ginger production using the existing varieties and improved agronomic practices.

Figure 2 *Ginger experiments by EIAR*

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Annex I

Area of land under different suitability classes for ginger production by region

Regions	Highly suitable		Moderately suitable		Marginally suitable		Not suitable	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Addis Ababa	0	0.0	0	0.0	768	1.4	53,147	98.6
Afar	0	0.0	15,880	0.2	8,796	0.1	9,465,441	99.7
Amhara	529,476	3.4	2,245,016	14.4	2,356,672	15.1	10,429,168	67.0
BSG	2,326,464	46.2	2,122,888	42.1	435,096	8.6	154,254	3.1
Dire Dawa	0	0.0	0	0.0	248	0.2	105,274	99.8
Gambela	382,196	12.2	1,035,428	33.0	366,028	11.7	1,358,906	43.2
Harari	0	0.0	0	0.0	0	0.0	37,156	100.0
Oromia	2,088,396	6.5	4,443,404	13.8	2,892,012	9.0	22,887,044	70.8
Sidama	8,512	1.3	157,800	23.3	72,160	10.7	438,647	64.8
SNNP	583,188	9.2	1,603,032	25.3	812,384	12.8	3,342,706	52.7
Somali	0	0.0	188	0.0	1,492	0.0	31,288,060	100.0
SWEP	1,517,536	38.8	1,038,664	26.6	191,112	4.9	1,164,525	29.8
Tigray	68	0.0	318,088	6.1	68,764	1.3	4,873,210	92.6
Total	**7,435,836**	**6.6**	**12,980,388**	**11.5**	**7,205,532**	**6.4**	**85,597,538**	**75.6**

Annex II

Area (in ha) of land under different suitability classes for ginger production by Zonal administrative

No	Zone	Highly suitable	Moderately suitable	Marginally suitable	No	Zone	Highly suitable	Moderately suitable	Marginally suitable
1	Metekel	1287900	941472	243408	34	Sidama	8468	157660	72332
2	Kamashi	670400	282504	38464	35	West Guji	8392	30588	7056
3	Mirab Omo	634820	158704	16716	36	E. Gojam	6768	265128	357304
4	West Wellega	583744	573560	46676	37	Gedeo	4816	40544	17936
5	East Wellega	464868	613236	201500	38	Burji	3504	20220	3004
6	Assosa	356208	644948	116776	39	Konso	3344	127656	2716
7	Kelem Wellega	287772	474356	155944	40	Derashe	1576	47136	9592
8	Awi	272604	329768	121468	41	Alle	1440	44288	11428
9	Ilu Aba Bora	244704	612784	63004	42	West Arsi	696	78848	133160
10	Bench Sheko	238220	177248	22364	43	Guji	476	2536	96
11	Agnewak	217244	975472	201984	44	Yem Spec	352	29480	22864
12	Kefa	213828	438268	81248	45	S. Gondar	116	43940	409216
13	Jimma	199708	742540	435932	46	Western	64	281608	66156
14	Dawuro	195752	143344	58512	47	N.Shewa (OR)	44	122124	158544
15	Gofa	190680	169068	44036	48	Guraghe	28	93596	210964
16	Konta Special	175112	46752	6052	49	Arsi	20	62092	172884
17	South Omo	171632	240740	10944	50	N. Gondar	0	161760	115940
18	Majang	166156	60292	188	51	S.W. Shewa	0	49852	237908
19	Horo Gudru Wellega	139132	247356	57952	52	N. Shewa (AM)	0	43856	148312
20	W. Gojam	123344	329636	464828	53	N.W. Tigray	0	35964	2560
21	Buno Bedele	120684	265608	158760	54	W. Hararge	0	29544	207656
22	Wolayita	73992	248392	49592	55	Halaba	0	17808	44604
23	Central Gondar	68136	716772	458344	56	Gabi/Zone 3	0	15780	8660
24	Sheka	60264	74396	6340	57	East Bale	0	15168	50000
25	W. Gondar	56848	345724	153036	58	E. Shewa	0	13968	55324
26	Gamo	43072	373768	69392	59	E.Hararge	0	11760	188804
27	Amaro	31204	23908	2116	60	S. Wello	0	6260	117564
28	Basketo	25972	12268	2528	61	Finfine Spec.	0	5136	120676
29	Bale	21808	95028	88780	62	Itang	0	528	108248
30	Kembata Tembaro	16856	25864	48328	63	Borena	0	304	0
31	West Shewa	15616	397384	350564	64	Siti	0	172	1416
32	Hadiya	14968	89548	159120	65	Siltie	0	100	103580
33	Mao Komo	12444	254000	36400					

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