Influence of altitude and management system on coffee quality in Mount Elgon, Uganda

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Background

- Coffee is one of Uganda's most important cash crops providing up to 30 % of foreign exchange earnings. Many people in Uganda are involved in coffee cultivation and its related activities.
- Climatic changes will increasingly affect both coffee quantity and quality, thereby also influencing livelihoods of farmers.
- The aim of the study was to assess the impact of altitude and management system on coffee quality, in order to give recommendations to improve coffee quality, also under future climate scenarios.

Methods

- 134 smallholder farms producing Arabica coffee in Mt. Elgon region were selected, representing three altitude levels [< 1400 masl (low), 1400 – 1700 masl (mid), > 1700 masl (high)] and three management systems [coffee open sun (CO), coffee banana (CB), coffee tree (CT)].

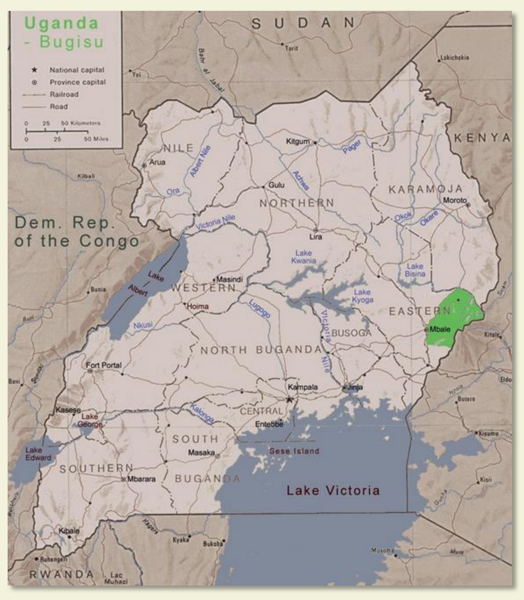

Figure 1: Map of Uganda with Mt. Elgon region in green color.

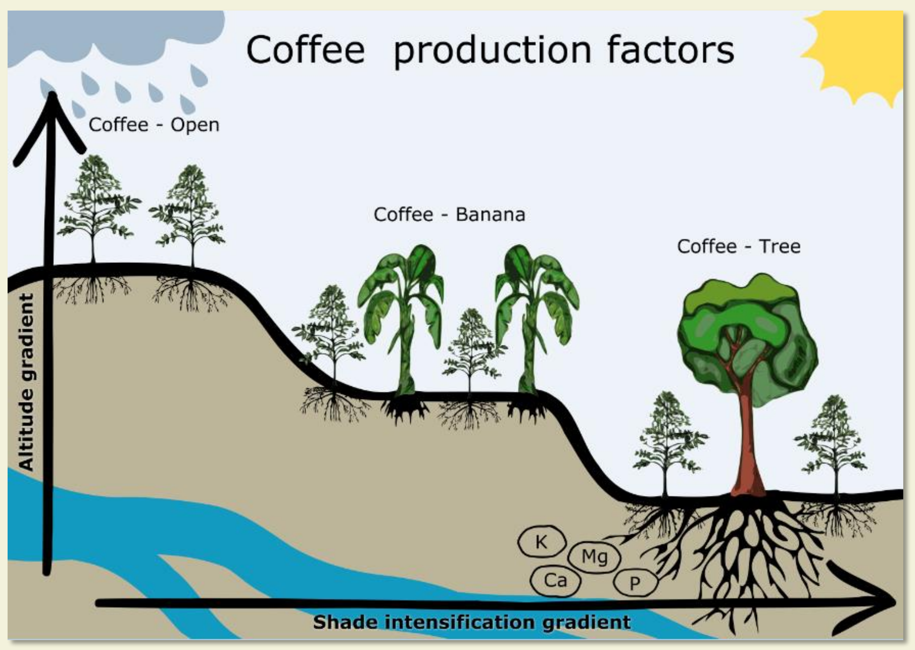

Figure 2: Exemplary presentation of three altitude levels and management systems at Mt. Elgon. All management systems can be found at each altitude level.

- During harvesting season 2015, mature coffee cherries were collected, processed and analyzed based on biophysical and organoleptic quality parameters, representing potential coffee quality.
- 35 additional parchment samples were bought from farmers for analyzing actual (farmer processed) quality by means of the same parameters. Additional interviews were conducted to assess farmers' quality perception.

Figure 3: Several steps of data collection: harvesting, processing, drying and cupping (from left to right) .

Conclusions

- Management systems (representing shade gradients) did not influence coffee quality in Mt. Elgon, whereas more favorable climatic conditions at higher altitudes increased coffee quality.
- Moving upslope might be an adaption strategy under future climate scenarios, but this requires practical feasibility.
- Better of post-harvest management, e.g. floating before pulping and improvement of drying conditions, has the potential to reduce the quality gap between actual and potential quality, independent of changing climate conditions.

Figure 4: Cultivation and processing of coffee at Mt. Elgon: coffee field, collection of harvested coffee cherries and drying of parchment coffee (from left to right).

Results

- There was a clear trend towards a better quality with increasing altitude for most biophysical and organoleptic variables. The influence of management system on quality was not significant (Fig. 5, Table 1).
- For most quality indicators potential quality was better than actual quality (Fig. 6, Table 2).
- Around 40% of farmers overestimated their quality, whereas 51 % were consistent with measured quality (bean size) (Fig. 7).

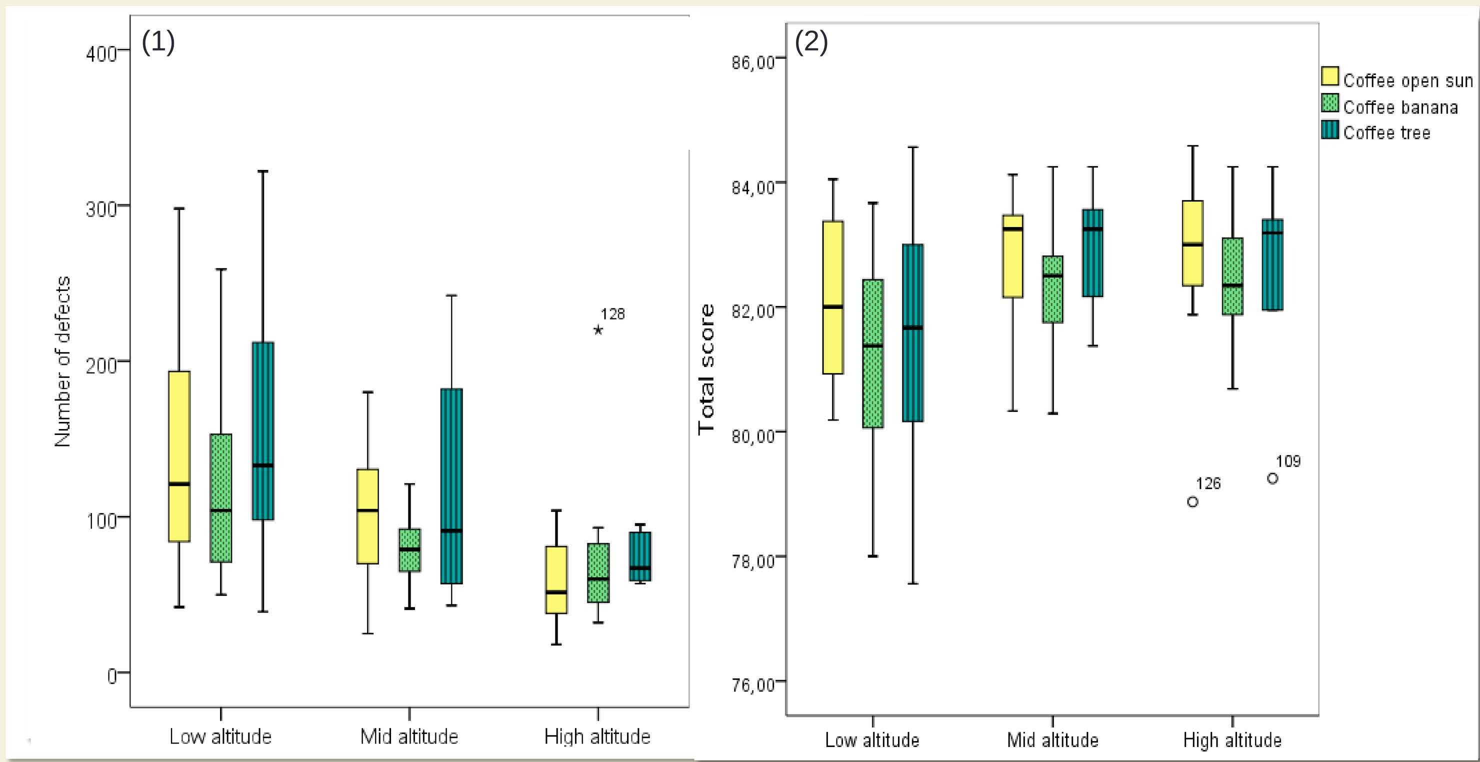

Figure 5: Box plots showing (1) total defects and (2) final cupping score for the three altitude levels and management systems.

Table 1: Two factor ANOVA to test the influence of altitude and management system on (1) total defects and (2) final cupping score.

Number of observations = 133; (1) R^2 = 0.295; Adjusted R^2 = 0.249, (2) R^2 = 0.126, Adjusted R^2 = 0.070

Source	Partial SS	df	MS	F	P(>F)
(1) Total defects					
Corrected Model	184664.262	8	23083.033	6.473	0.000***
Intercept	1121754.041	1	1121754.041	314.587	0.000***
Altitude	107381.997	2	53690.999	15.057	0.000***
Management	17032.152	2	8516.076	2.388	0.096
Altitude*Management	3961.232	4	990.308	.278	0.892
Error	442158.761	124	3565.796		
Total	2300331.000	133			
Corrected Total	626823.023	132			
(1) Cupping score					
Corrected Model	140.946^b	8	17.618	2.241	0.029
Intercept	2902010.168	1	2902010.168	369147.939	0.000***
Altitude	90.876	2	45.438	5.780	0.004**
Management	26.293	2	13.146	1.672	0.192
Altitude*Management	9.925	4	2.481	0.316	0.867
Error	974.810	124	7.861		
Total	3570799.017	133			
Corrected Total	1115.757	132			

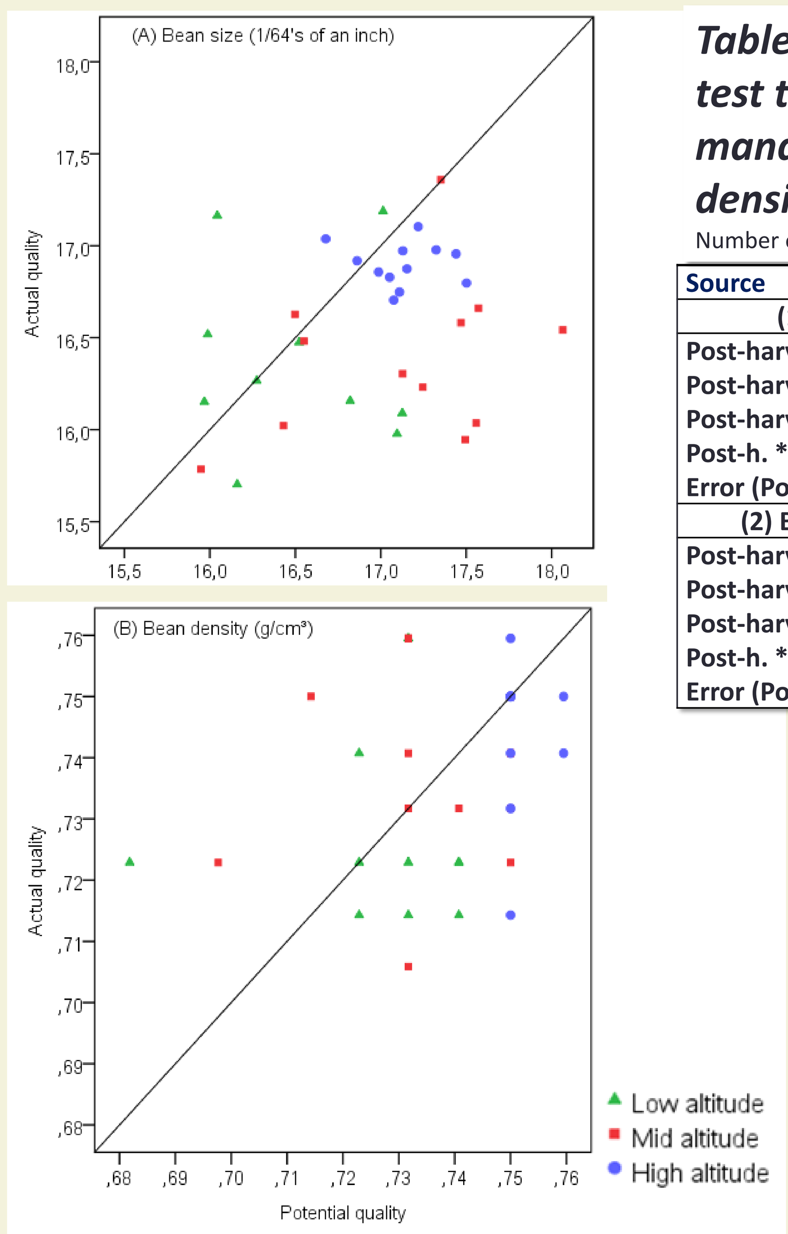

Figure 6: Comparison between potential and actual quality of (A) bean size (1/64's of an inch) and (B) bean density (g/cm³).

Table 2: Repeated two factor ANOVA to test the influence of post-harvest management on (1) bean size and (2) bean density.

Number of observations = 133

Source	Partial SS	df	MS	F	(P > F)
(1) Bean size					
Post-harvest	1.816	1	1.816	11.998	0.002**
Post-harvest * Alt.	1.540	2	0.770	5.088	0.014*
Post-harvest * Man.	0.556	2	0.278	1.836	0.180
Post-h. * Alt. * Man.	0.542	4	0.136	0.895	0.482
Error (Post-harvest)	3.784	25	0.151		
(2) Bean density					
Post-harvest	5.4E-005	1	5.4E-005	0.477	0.496
Post-harvest * Alt.	0.000	2	0.000	1.001	0.382
Post-harvest * Man.	0.000	2	0.000	1.010	0.379
Post-h. * Alt. * Man.	0.003	4	0.001	5.812	0.002**
Error (Post-harvest)	0.003	25	0.000		

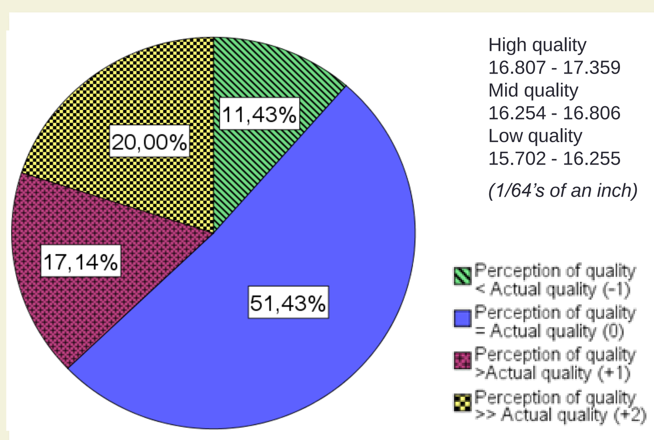

Figure 7: Comparison of farmers' perception with measured bean size based on three quality groups.

Acknowledgements

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