Annex 11: Regression analyses

The household food security and nutrition conceptual framework is the basis for the causal analysis. Based on this framework, indicators for are These indicators are specific for the Rwandan context.

Variables to be included in the analysis of the causes for the observed variations in food security and chronic malnutrition were selected from the household survey, community questionnaire and from geo-referenced secondary data. The selection was done in two steps: First a list of variables was built using the secondary data analysis (including the causal analysis done for the 2009 CFSVA), then a selected number of new relevant variables, explored for this 2012 CFSVA was added to this list.

These variables were all tested against the dependent variables through bivariate analysis such as correlation, t- test, anovas chi-square. The ones that didn't show an association with the dependent variables were then dropped.

Causes of food insecurity

The General Linear Model (GLM) was used (integrating Multiple Linear Regression with Analysis of Variance - ANOVA), it allows for factorial and continuous independent variables at the same time. The dependent variable (linear) which the model tries to explain is the food consumption score (FCS). The independent variables (linear–categorical) are indicators of asset endowments of the households, of the political, economic and institutional environment they are in, and of their adopted livelihood strategies. The GLM[1] allows assessing the effect of each "determinant" (or independent variable) on food-consumption, while controlling for all the other factors in the model. We can thus study the "net effect" of each variable without confusing this effect with the influence from other factors that might be correlated with the particular variable under study.

At the bivariate level, the FCS was associated with variables typically considered related to food security, including wealth, food expenditures, and other vulnerability factors.

Not all factors showed the expected effect in this data set. For example, no statistically significant effect was observed from marital status, per capita expenditure, share of food expenditure, assistance received during the past 12 months, village soil fertility index, village soil erosion. When all other variables are taken into account these factors only weakly describe differences in food security in the Rwandan context. However, they may still be associated with food insecurity and may be partly captured by other factors in the model, for example soil fertility and soil erosion are likely to be captured in the livelihood zoning.

[1] SPSS GLM for complex samples is utilized to analyze the data

The resulting model fits reasonably well for a household survey (R^2 = 0.443). The main effects and regression coefficients are given in the tables below.

Tests of Model Effects[a]

Source	df1	df2	Wald F	Sig.
(Corrected Model)	45.000	676.000	73.284	.000
(Intercept)	1.000	720.000	1437.103	.000
Village status	2.000	719.000	3.851	.022
Livelihood	9.000	712.000	11.441	.000
Size of land	5.000	716.000	12.877	.000
Head of hh educ	6.000	715.000	11.611	.000
Livelihood zone	12.000	709.000	22.584	.000
Number income activities	1.000	720.000	12.644	.000
HH size	1.000	720.000	10.902	.001
Crowding index	1.000	720.000	23.811	.000
Livestock Ownership	1.000	720.000	7.410	.007
Wealth index	1.000	720.000	268.747	.000
Number of household crops	1.000	720.000	44.879	.000
Head of household age	1.000	720.000	15.797	.000
Food from harvest available in April	1.000	720.000	8.759	.003
Distance from market	1.000	720.000	4.566	.033
Distance from main road	1.000	720.000	5.521	.019
Kitchen garden	1.000	720.000	8.457	.004

Parameter Estimates[b]

Variable	Parameter	Estimate	95% Confidence Interval		Hypothesis Test		
			Lower	Upper	t	df	Sig.
	(Intercept)	67.666	61.110	74.222	20.263	720.000	.000
Village status	Urban	3.287	.625	5.948	2.424	720.000	.016
	Rural	.068	-1.904	2.041	.068	720.000	.946
	Semi/peri-urban	.000[a]	.	.	.	.	.
Livelihood	Agriculturalist (low income)	-4.240	-5.648	-2.831	-5.909	720.000	.000
	Agro-pastoralists	-.284	-2.132	1.564	-.302	720.000	.763
	Agriculture and unskilled daily labour	-4.890	-6.752	-3.029	-5.157	720.000	.000
	Agricultural workers	-3.228	-5.181	-1.276	-3.246	720.000	.001
	Informal sale	3.349	.472	6.227	2.285	720.000	.023
	Employee and business	3.011	.275	5.748	2.160	720.000	.031
	Agro seller	1.156	-1.136	3.448	.990	720.000	.322
	Agro artisan	2.039	-1.170	5.248	1.247	720.000	.213
	Others marginal livelihoods	-.798	-3.098	1.501	-.682	720.000	.496
	Agriculturalist (medium/high income)	.000[a]	.	.	.	.	.
	No land	3.875	1.611	6.138	3.361	720.000	.001
	<0.1 ha	-3.104	-4.614	-1.594	-4.036	720.000	.000
	0.1 - 0.19 ha	-1.418	-2.775	-.060	-2.050	720.000	.041
	0.2 - 0.49 ha	-.745	-1.961	.470	-1.204	720.000	.229
	0.5 - 0.99 ha	-.825	-2.060	.409	-1.313	720.000	.190
	>1 ha	.000[a]	.	.	.	.	.
head of household level of education	No School	-16.668	-21.303	-12.034	-7.061	720.000	.000
	Some Primary	-17.611	-22.217	-13.005	-7.507	720.000	.000
	Completed Primary	-16.670	-21.279	-12.060	-7.100	720.000	.000
	Some secondary	-12.471	-17.017	-7.925	-5.386	720.000	.000
	Vocational School	-17.196	-22.370	-12.022	-6.525	720.000	.000
	Completed Secondary	-11.373	-16.309	-6.437	-4.524	720.000	.000
	Some / Completed University or College	.000[a]	.	.	.	.	.
Livelihood zones	Kigali City	1.346	-2.579	5.272	.673	720.000	.501
	Lake Kivu Coffee Zone	-11.178	-14.716	-7.641	-6.204	720.000	.000
	West Congo-Nile Crest Tea Zone	-9.524	-13.236	-5.812	-5.037	720.000	.000
	Northwest Volcanic Irish Potato Zone	-5.816	-9.373	-2.259	-3.210	720.000	.001
	East Congo-Nile Highland Subsistence Farming Zone	-6.673	-10.017	-3.329	-3.918	720.000	.000
	Central Plateau Cassava and Coffee Zone	-2.301	-5.609	1.006	-1.366	720.000	.172
	Northern Highland Beans and Wheat Zone	-5.898	-9.743	-2.054	-3.012	720.000	.003
	Central-Northern Highland Irish Potato, Beans and Vegetable Zone	-3.396	-6.987	.196	-1.856	720.000	.064
	Bugesera Cassava Zone	-4.819	-8.501	-1.136	-2.569	720.000	.010
	Eastern Plateau Mixed	-7.099	-10.754	-3.444	-3.813	720.000	.000

Variable	Parameter	Estimate	95% Confidence Interval		Hypothesis Test		
			Lower	Upper	t	df	Sig.
	Agriculture Zone						
	Southeastern Plateau Banana Zone	.152	-3.248	3.552	.088	720.000	.930
	Eastern Agropastoral Zone	1.424	-2.566	5.413	.701	720.000	.484
	Eastern Semi-Arid Agropastoral Zone	.000[a]	.	.	.	.	.
Number income activities		1.336	.599	2.074	3.556	720.000	.000
HH size		.368	.149	.587	3.302	720.000	.001
Crowding index		-.803	-1.126	-.480	-4.880	720.000	.000
Livestock Ownership		.931	.260	1.603	2.722	720.000	.007
Wealth index		5.727	5.041	6.413	16.394	720.000	.000
Number of household crops		1.541	1.090	1.993	6.699	720.000	.000
Head of household age		-.048	-.072	-.024	-3.974	720.000	.000
Food from harvest available in April		1.206	.406	2.007	2.960	720.000	.003
Distance from market		-.007	-.013	-.001	-2.137	720.000	.033
Distance from main road		-.150	-.275	-.025	-2.350	720.000	.019
Do you have a household vegetable plot /garden?:	No	-1.069	-1.791	-.347	-2.908	720.000	.004
	Yes	.000[a]	.	.	.	.	.

a. Set to zero because this parameter is redundant.

Causes of chronic malnutrition

All children between 6 and 59 months

Multivariate stepwise logistic regressions were conducted to explore the individual level predictors of stunting. Logistic regressions using dichotomous variables to indicate malnutrition (stunted or not) were preferred because the method allows comparing risks under different conditions and yields results that are easily interpretable. The outcome for the regression was stunting (yes or no). Like the GLM, the logit allows assessing the effect of each "determinant" (or independent variable) on stunting, while controlling for all the other factors in the model. We can thus study the "net effect" of each variable without confusing this effect with the influence from other factors that might be correlated with the particular variable under study.

At the bivariate level, the stunting was associated with variables typically considered related to malnutrition, including food consumption, food expenditures, and vulnerability factors. Not all factors showed the expected effect in this data set. For example, no statistically significant effect was observed from household food consumption, household livelihood groups, household kitchen garden, household type of toilet facility, mother hand washing practices. Hence, these factors only weakly describe differences in chronic malnutrition in the current dataset. However, they may still be associated with stunting and may be partly captured by other factors in the model.

Confounding factors in this model were: child received deworming tablets in the last 6 months, child sick and went to health facility, water treatment.

The summary tables on main effects and regression coefficients are given below.

Tests of Model Effects

Source	df	Wald Chi-Square	Sig.
(Corrected Model)	46.000	363.354	.000
(Intercept)	1.000	27.675	.000
Mother stunted	2.000	13.884	.001
Mother Education	3.000	11.151	.011
Size of baby at birth	4.000	42.877	.000
Child sex	1.000	19.490	.000
Household wealth index	4.000	15.647	.004
Child received deworming tablets in the last 6 months	1.000	.151	.697
Child sick and went to Health Facility	2.000	2.376	.305
Water treatment	5.000	3.790	.580
Household reported Ubudehe category	4.000	9.881	.042
Livelihood zones	12.000	65.733	.000
Village status	2.000	10.558	.005
Mother's age in years	1.000	4.826	.028
Child's age in completed months	1.000	35.883	.000
(Child's age in completed months)2	1.000	31.285	.000
Percentage of not suitable land from cell	1.000	5.134	.023
Estimated time from village to the nearest hospital	1.000	4.106	.043
Crowding index	1.000	14.221	.000

Parameter Estimates

	Parameter	B
	(Intercept)	2.530
Mother stunted	unknown	.596
	not stunted	.834
	stunted	.000
Mother Education	No education	-1.093
	Some or completed primary	-.949
	Some Secondary or Vocational	-.901
	Completed Secondary or above	.000
Size of baby at birth	Very large	1.327
	Larger than normal	1.180
	Normal	.714
	Smaller than normal5 = very small	.464
	very small	.000
Child sex	Male	-.340
	Female	.000
Household wealth index	1st poorest	-.495
	2nd	-.296
	3rd middle	-.494
	4th	-.418
	5th wealthiest	.000
Child received deworming tablets in the last 6 months	No	.041
	Yes	.000
Child sick and went to Health Facility	Child not sick	-.083
	Sick child did not go to health facility	-.179
	Sick child went to health facility	.000
Water treatment	dirty boiled or ceramic	.166
	dirty chlorine	-.007
	dirty untreated	-.046
	improved boiled or ceramic	.121
	improved chlorine	-.034
	improved untreated	.000
Household reported Ubudehe category	don't know	-1.026
	abject poverty	-1.352
	poor	-1.123
	resourcefull poor	-1.015
	food or money rich	.000
Livelihood zones	Kigali City	.630
	Lake Kivu Coffee Zone	-.274
	West Congo-Nile Crest Tea Zone	-.217
	Northwest Volcanic Irish Potato Zone	-.821

	Parameter	B
	East Congo-Nile Highland Subsistence Farming Zone	-.107
	Central Plateau Cassava and Coffee Zone	.042
	Northern Highland Beans and Wheat Zone	-.775
	Central-Northern Highland Irish Potato, Beans and Vegetable Zone	.109
	Bugesera Cassava Zone	-.228
	Eastern Plateau Mixed Agriculture Zone	-.142
	Southeastern Plateau Banana Zone	.213
	Eastern Agropastoral Zone	-.009
	Eastern Semi-Arid Agropastoral Zone	.000
Village status	Rural	.138
	Urban	.641
	Slum	.000
Mother's age in years		.013
Child's age in completed months		-.078
(Child's age in completed months)2		.001
Percentage of not suitable land from cell		-.007
Estimated time from village to the nearest hospital		-.002
Crowding index		-.114

Children between 12 and 23 months

A separate model was run for children between 12 and 23 months to isolate the effect of child food consumption and feeding practices.

Confounding factors for this model included: child access to health services, type of water consumed in the household, Child receiving deworming tablets in last 6 months, household Water treatment, child received anything else than breast milk in first 6 months, child ate formula the day before, eggs, tubers or meat.

The summary tables on main effects and regression coefficients are given below.

Tests of Model Effects

Source	df	Wald Chi-Square	Sig.
(Corrected Model)	26.000	76.249	.000
(Intercept)	1.000	11.103	.001
Child sex	1.000	13.450	.000
Child's age in completed months	1.000	13.542	.000
Size at birth	4.000	20.650	.000
Mother Stunted	2.000	5.527	.063
Mother Education	4.000	10.401	.034
Deworming tablets in last 6 months	1.000	.541	.462
Water treatment	5.000	4.371	.497
Anything else than breast milk in first 6 months	1.000	1.093	.296
Milk or Yogurt	1.000	5.129	.024
Formula	1.000	1.223	.269
Bouillie	1.000	7.315	.007
Eggs	1.000	1.873	.171
Beans	1.000	5.522	.019
Tubers	1.000	1.505	.220
Meat	1.000	.007	.935

Parameter Estimates

	Parameter	B
	(Intercept)	2.038
Child sex	Male	-.536
	Female	.000
Child's age in completed months		-.089
Size at birth	Very large	1.193
	Larger than normal	1.137
	Normal	.398
	Smaller than normal	.107
	Very small	.000
Mother Stunted	unknown	1.268
	Not stunted	1.429
	Stunted	.000
Mother Education	Unknown	-.818
	No education	-1.206
	Some or completed primary	-.696
	Some Secondary or Vocational	-.340
	Completed Secondary or above	.000
Deworming tablets in first 6 months	No	-.134
	Yes	.000
Water treatment	Dirty boiled	.488
	Dirty chlorine	.277
	Dirty untreated	.291
	Improved boiled	.141
	Improved chlorine	.116
	Improved untreated	.000
Child received anything else than milk in the first 6 months	No	.167
	Yes	.000
Milk or Yogurt	No	-.474
	Yes	.000
Formula	No	-.789
	Yes	.000
Bouillie	No	.439
	Yes	.000
Eggs	No	-.645
	Yes	.000
Beans	No	.348
	Yes	.000
Tubers	No	.195
	Yes	.000
Meat	No	.030
	Yes	.000