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Crop-Specific EU Aid and Smallholder Food Security in Sierra Leone

Silvia L. Saravia-Matus [a,*], Sergio Gomez y Paloma [b], Sebastien Mary [c]

[a] *International Senior Consultant at European Commission – Joint Research Centre in Seville, Santiago, Chile*
[b] *European Commission – Joint Research Centre in Seville, Spain*
[c] *Du Paul University, Chicago, U.S.A.*

Abstract

The article analyses the viability of promoting crop-specific programs as a mean to improve smallholder net farm income and food security. The case study explores the relevance of European Union Stabilisation of Export Earnings (STABEX) funds in supporting Sierra Leone's agricultural development agenda. By analysing the drivers of food security for a number of targeted smallholders in the two most important agricultural zones of Sierra Leone, it is possible to compare the suitability of crop-specific support (in rice, cocoa and coffee) versus general aid programs (public infrastructure, on and off farm diversification opportunities, sustainable practices, access to productive assets, etc.). The results indicate that crop diversification strategies are widespread and closely related to risk minimisation and enhanced food security among smallholders. Similarly, crop-specific programs mainly focusing on commercialisation tend to overlook important constraints associated to self-consumption and productivity.

Keywords: EU aid policy, food security, smallholders, Sierra Leone, crop specialisation, crop diversification

1 Introduction

The Government of Sierra Leone requested in 2005 the use of European Union STABEX (Stabilisation of Export Earnings) funds (an instrument of the 8th European Development Fund) for the enhancement of national rice production and the rehabilitation of cocoa and coffee plantations (Government of Sierra Leone, 2007). The objective of the STABEX-funded projects was to achieve food security goals through the improvement of the agricultural sector (Gomez y Paloma *et al.*, 2012). Most of the support provided (4,378,000 EUR) was aimed at crop-specific commercial, organisational and technical assistance aimed at improving net farm income of smallholders [1].

In order to assess the relevance of EU aid policy in Sierra Leone, a 2009 survey designed by the Joint Research Centre of the European Commission is used (Gomez y Paloma *et al.*, 2012) [2]. Although there are no data reflecting interviewees' conditions prior to 2009, the cross-sectional survey provides an in depth picture of smallholders' farm income and crop portfolio. The

* Corresponding author
Email: silvia.saraviamatus@gmail.com
Phone: +56 9 75867 331

[1] Two separate implementing agencies were selected: Action Aid addressed rice cultivation in the Northern districts of Bombali and Tonkolili, while the The Deutsche Welthungerhilfe worked in the Eastern districts of Kenema, Kailahun and Kono supporting cocoa and coffee production. Each implementing agency operated through local farmer organisations (Gomez y Paloma *et al.*, 2012).

[2] The survey is based on primary data collected in 600 face-to-face interviews located in the main agricultural areas of Sierra Leone. Sample sizes throughout the different areas are representative of the agricultural population in the Northern and Eastern Regions, five districts, 11 chiefdoms, and 39 villages.

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dataset offers valuable insights on the limitations and opportunities of crop-specific technical assistance in the context of rural, post-conflict settings as well as the key food security constraints faced by smallholders under tropical agricultural systems. From the experience in Sierra Leone it is possible to draw key lessons for future agricultural assistance programs or EU food aid and development policies. It can thus be argued that the paper is innovative as *a)* it is using farm-household level data which provides a detailed picture of smallholder's farm income and crop portfolio and *b)* it introduces a novel approach for analysing the capacity of the STABEX transfers aimed at increasing smallholder food security in Sierra Leone via crop-specific support. This examination is particularly relevant in the context of UN Sustainable Development Goals (SDG) 1 and 2 [3].

2 Method of analysis

Smallholders in low income countries under tropical settings often rely on their own production to secure (partially or entirely) their consumption, which is often far from reaching the nutritional balance required for a healthy life (Saravia-Matus *et al.*, 2012). In the present case study, the extent of food insecurity among smallholders is examined by contrasting agricultural income to a contextualised consumption level or basic needs basket. In other words, the ability of smallholders to become food self-sufficient is assessed on the basis of their agricultural performance or net farm income [4]. Frequently used thresholds include poverty lines (PL) and Food Consumption Scores (FCS). But for the present analysis FCS are preferred because the information on full income at farm-household level (i.e. farm as well as non-farm income sources) is not available. Thus, only the capacity to generate sufficient food intake from agricultural activities is captured in this analysis.

The key difference between PL and FCS is that FCS focus on the different levels and diversity of food consumption considering nutritional aspects that are country- and region-specific. FCS go beyond capturing the expenditure needed to attain the minimum daily nutritional requirement of 2700 calories per adult equivalent (usually employed in the extreme and full poverty lines) and include diet diversity, food frequency, and relative nutritional importance of different food groups [5]. Further rationale for using dietary diversity in the FCS construction is that it reflects the extent of adequate intake of essential nutrients. Dietary diversity is thus intended as a proxy of access to food (at household level), intake of energy and macronutrients and intake of micronutrients (FAO, 2008). Another main difference with respect to poverty lines is that other non-food expenditures such as shelter, access to safe water, education, health care are not covered in FCS expenditures. The latter is convenient given that only Net Farm Income (NFI) is contrasted against the FCS threshold. If full income information were available a poverty line threshold would be a more suitable choice.

The identification of smallholders who are food insecure on the basis of their agricultural performance is completed by an econometric assessment of the probability of their NFI to fall below a given threshold (Lovendahl & Knowles, 2005). In other words, the probability of being in a situation of food insecurity due to achieving an insufficient NFI level can be assessed through models of binary response variables (Baum, 2006). The resulting dependent variable "food poor" can be expressed as a binary variable taking the value of 1 if the smallholder reports a NFI below the identified threshold and 0 otherwise. For analytical purposes the "FCS poor level" threshold (equivalent to 0.30 $US per day per adult equivalent) is selected because it refers to the capacity of smallholders to generate NFI that could cover at least the minimum food consumption level for subsistence taking into consideration the rural context of Sierra Leone (World Food Program, 2008). Within this set up the binary response variable model can highlight the probability of a smallholder being categorised as ¨food poor¨ controlling for a series of factors. The model may be expressed as follows:

$$Prob\,(Food\ Poor_i = 1 \mid x_i) = F(x_i\,\beta)$$

[3] SDG 1: End poverty in all its forms everywhere. SDG2: End Hunger, Achieve Food Security and Improve Nutrition and Promote Sustainable Agriculture
https://sustainabledevelopment.un.org/

[4] For a detailed assessment of net farm income calculation procedures refer to Saravia-Matus & Gomez y Paloma (2014).

[5] The FCS procedure is to ask interviewees (in this case inhabitants of rural areas in Sierra Leone) about frequency of consumption (in days) over a recall period of the past 7 days. Food items are then grouped into 8 standard food groups with a maximum value of 7 days/week. The consumption frequency of each food group is multiplied by an assigned weight that is based on its nutrient content. Those values are summed obtaining the Food Consumption Scores which are then classified into adequate or poor levels (World Food Program, 2008). In Sierra Leone the FCS classified as Poor/Borderline varies between 0 to 35 and it is equivalent to 0.30 USD per day; while the Adequate FCS is above 35 which is closer to 0.40 USD per day. These expenditures are below the Full and Extreme Poverty Line of 2 USD and 1 USD per day. Note that in 2009 1 USD = 1700 SLL (Sierra Leonean Leone) approximately.

where F is the logistic (or normal) cumulative distribution function (CDF) [6]. x_i is a vector of values for the i^{th} observation of the explanatory variables and β is a vector of parameters. A constant was also included in the calculation. In this respect, the Sierra Leone dataset offers a series of theoretically relevant variables which are grouped into four categories: (i) *socio-demographic traits*, (ii) *productive asset ownership and access to infrastructure*, (iii) *livelihood diversification strategies* and (iv) *agricultural practices and crop portfolio* (Table 1).

It is expected that higher dependency ratios, higher educational achievements and enjoying a relevant position within the community may have a positive impact on NFI levels. Concerning gender, Ragasa (2012) argues that female farm-household heads experience more obstacles in the organisation of production and commercialisation activities. Similarly, women face constraints regarding their possibility to participate in innovation processes and access information, inputs (including cash) and extension services (FAO, 2010–2011) ultimately increasing their probability of being food insecure. Age may contribute either positively or negatively depending on whether it is correlated to higher dependency ratios (that is the farm-household head is far too old for productive work) or increased social capital that reduces transaction costs and increases NFI levels (which is associated to higher age as the individual has forged stronger long term relationships). Another relevant issue to consider is that there may be joint effects among the socio-demographic traits. For instance, female smallholders may report fewer years of education than their male counterparts and may not be as actively involved in community-level organisational structures as their male counter-parts.

In terms of productive assets, an increased access to land is expected to have a positive effect on NFI and consequently on food security. In the case of Sierra Leone, smallholders who are renting land are those who have limited access to this resource (Unruh & Turray, 2006). Consequently, if the smallholder relies on land rentals to secure land access, it is expected that this may have a negative impact on NFI levels and food security as there is an element of uncertainty besides increased cost (usually paid in kind i.e. rice bushels) [7]. In terms of storage capacity, if the smallholder farm-household is able to save part of their output for selling at different times throughout the years, it may indicate that higher selling prices may be achieved thus increasing NFI. Also seeds may be used for the next production cycle or for home consumption at times of scarcity or higher retail prices. Higher distances to markets imply higher transportation costs (and possibly transaction costs) and fewer sales or overall percentage of sold output and thus lower NFI levels. The ownership of a mobile phone is also expected to have a positive effect on NFI although alternative interpretations are also plausible. Jayne *et al.* (2011) argue that while a majority of sub-Saharan farmers now own or have access to a mobile phone, few feel that owning a mobile phone helps them find a better price for their farm output. Instead, the majority of farmers use their phones to notify a buyer that they have agricultural produce to sell, not to negotiate a price, or to search for price differences between buyers.

In terms of livelihood diversification indicators, the reception of gifts or remittances and having agriculture as the only income are considered. If gifts and remittances are used to invest in farm activities, NFI may increase; alternatively, on the basis of this inflow the smallholder may decide to reduce their farm labour efforts resulting in lower NFI levels. Relying on only agricultural income indicates that farm-households may be rather vulnerable to changes in agricultural markets and thus more likely to be food insecure if their NFI is reduced.

Agricultural practices and decisions around crop portfolio are also expected to have an effect on NFI and in the probability of achieving food security. In the case of fallowing (a practice expected to increase soil fertility, yields and NFI in the long term) a negative effect on NFI may be reported in the short term as land is taken out of cultivation (McCarthy *et al.*, 2011). In a study by Solis *et al.* (2008) which explored the connection between technical efficiency and environmental sustainability, smallholders that have a more diversified farm production plan (as well as off-farm work) reported both higher efficiency and sustainability. These findings largely coincide with Coelli & Fleming (2004) who argue that, in peasant economies, diversified production plans can lead to productivity gains that increase returns to land and labour, thus increasing food security status as supported by agricultural endeavours.

[6] For ease of interpretation, the analysis is made on the basis of the logistic CDF. This allows to calculate the log of the odds ratio which conveniently re-expresses the probability in terms of the odds of $y = 1$.

[7] In Sierra Leone (as in other African countries) land-owning families may decide to revoke the agreement at any moment and tenants are not allowed to plant trees as they may reduce the capacity of owners to claiming back their land. Meanwhile, trees are, inter alia, a symbol of land ownership (Unruh & Turray, 2006). Unruh & Turray (2006) describe that the prohibition against planting economic trees or making other long-term improvements to the land for people from outside the chiefdom has strong negative food security implications.

Table 1: *Explanatory variables of smallholder food insecurity*

Farm-household traits	
Dependency ratio	Number of dependent household members over 18 years old / Total number of household members
Age of household head	Years
Gender of household head	1 if Household head if Female; 0 if it is Male
Education of household head	Years of school attendance
Social capital of household head	1 if Farm-household head holds a position in local government or communal organisation (councillor, section chief, village chief, village headman). 0 if ordinary citizen
Access to productive assets & infrastructure	
Acres per adult equivalent household member	Number
Land rental	1 if farm-household rents land; 0 if not
Storage	Percentage of harvested crop which was stored
Mobile phone	1 if Household head owns a mobile phone; 0 if not
Distance to market	Kilometres
Livelihood diversification strategies	
Only agricultural income	1 if the farm proceed is the only reported income source of the household; 0 if additional income sources are reported: remittances, gifts, non-farm activities (i.e. petty trading, artisan etc.)
Remittances & gifts	1 if remittances or gifts have been received by the farm-households; 0 if not
Agricultural practices & crop portfolio	
Fallow period	Number of years under fallow
Crop concentration/diversification	Shannon Index (0–1); Simpson Index (1 if < 0.5 and 0 if > 0.5)

In the present case study, smallholders' decisions between crop specialisation and diversification are particularly relevant since STABEX-funded initiatives were aimed at promoting the production and commercialisation of selected crops. To measure inter-crop diversity, the Shannon index is used. This index expresses proportional abundance or evenness, accounting for the land shares allocated to each crop as well as the number of crops. The index gives less weight to rare species than common ones, but is more sensitive to differences to small degrees of relative abundances than the Simpson index which is another widely used evenness index measure of diversity. Both indices are used in the empirical analysis.

3 Empirical findings

As stated, the aim of the binary response variable model estimation is to analyse the probability of smallholders to achieve NFI levels above or below a predefined food security threshold. All of the explanatory variables presented in Table 1 were included in the regression with the exception of gender and age because the latter appeared to be strongly correlated to social capital.

Table 2 presents the binary response model estimation under logistic CDF and introduces average marginal effects. These average individual marginal effects can be interpreted as partial effects on the probability to be identified as ¨food poor¨. Among the statistically significant traits, the condition of holding a relevant pos-

ition within the community (social capital) suggests that the smallholder will be less likely to fall under the food security threshold. That is 17 % lower probability of being identified as "food poor" than smallholders without this level of social capital as indicated in the marginal effects column (−0.1747). In terms of the dependency ratio, having a larger burden within the farm-household is positively related to being identified as "food poor" (16 % more likely to be identified as food insecure). Years of education which appeared as statistically insignificant may be associated to the general low educational levels observed in the rural areas of Sierra Leone.

Concerning livelihood diversification variables, only relying on agricultural income makes the smallholder more likely to be identified as food poor on the basis of the achieved NFI level. Similarly, farm-households receiving remittances and gifts appear to be those in most need; suggesting these resources may be used for subsistence rather than investment. Smallholders only relying on agricultural income and those receiving remittances and gifts have on average 13 % and 14 % higher probability, respectively, to be below the established food security threshold, *ceteris paribus*.

Regarding productive assets and infrastructure, only land availability per adult equivalent household member and the land rental dummy appear as statistically significant. As expected, the higher land availability, the less likely the smallholder is to be identified as food poor (−2.4 %), *ceteris paribus*. On the contrary, smallholders involved in land rental arrangements have on average 20 % higher probability to be "food poor". This may relate to the limitations and uncertainties associated to land tenants in Sierra Leone. For the case of storage and distance to markets, the statistical insignificance of these variables may be connected to the low market integration among the "food poor" smallholders.

Table 2: *Logit model estimation & average marginal effects after logit*

	Logit Dependent variable: FCS below poor		*Average marginal effects dependent variable: Pr (FCS below poor)*	
Farm-household traits				
Education of household head	0.0119	(0.0249)	0.0020	(0.0038)
Social Capital	−0.826 ***	(0.2493)	−0.1747 ***	(0.0456)
Dependency ratio	0.956 **	(0.4315)	0.1642 **	(0.0656)
Livelihood diversification				
Only agricultural income	0.688 ***	(0.2370)	0.1361 ***	(0.0384)
Remittances & gifts	0.735 ***	(0.2240)	0.1448 ***	(0.0356)
Productive assets & infrastructure				
Acres per adult equivalent household member	−0.141 *	(0.0770)	−0.241 *	(0.0117)
Land rental	1.070 ***	(0.3746)	0.2012 ***	(0.0525)
Storage	0.176	(0.6355)	0.0302	(0.0980)
Distance to market	−0.0156	(0.2140)	−0.0026	(0.0033)
Mobile phone	0.0956	(0.2681)	0.0199	(0.0488)
Agricultural practices				
Fallow period	−0.0904 ***	(0.0274)	−0.0155 ***	(0.0040)
Shannon index	−3.690 ***	(0.7456)	−0.6337 ***	(0.1063)
Constant	2.089 ***	(0.4419)		
Observations	540			

Standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$

The negative sign on the fallow practice suggests that smallholders who are able to keep land aside for improving soil fertility (and long term productivity) are less likely to be identified as food poor (−1.5 %) holding all other variables constant. Smallholders involved in fallowing are already capable of assuming the opportunity costs associated to this practice and maintain higher food security levels. Regarding the degree of crop diversification, captured through the Shannon Index, the negative sign suggests that smallholders maintaining a diversified crop portfolio (over 10 crops) are less likely to be 'food poor". In fact, the largest partial effect is associated to crop diversification practices reporting 63 % higher probability of *not* being identified as "food poor" if the smallholders have a highly diversified crop portfolio.

As evidenced in the logit regression results, the probability of being identified as food poor (under a very strict threshold of 0.30USD per person per day) was higher when smallholders had concentrated crop portfolios, could not undertake fallow practices, faced limited and/or uncertain land access, were only reliant on their agricultural activities for survival, had a larger number of dependent household members and reduced social capital within their community.

In order to explore the traits of the smallholders identified as "food poor" an agricultural typology is developed. The types of smallholders are defined on the basis of agro-ecological zones that may constrain the choice of crops cultivated and crop concentration/diversification indices. Each emerging type is then described in terms of food security, assets, market integration and output valuation. In the description of emerging types, the Richness Index is also introduced to illustrate how many and which kind of crops are produced. Table 3 provides an overview of the selected identification criteria, indicators and thresholds used to build the typology (Even *et al.*, 2016).

Table 4 presents the four basic emerging farm types. The "Crop Diversified" Types 1 & 3 representing both agro-ecologies and reporting on average 16 to 12 crops respectively account for 71.7 % of surveyed smallholders. Types 2 & 4, on the other hand represent the remaining percentage (28.3 %) and capture the "Crop Concentrated" smallholders reporting on average 6 and 4 crops in the sub-humid and humid zones respectively. Interestingly, in the humid or rainforest ecology there are very few crop concentrated smallholders (Type 4 represents only 5 % of surveyed smallholders in this agroecological region). In this zone, 95 % of surveyed smallholders prefer to combine cash tree crops with staple crops (Type 3). In the sub-humid zone, however, the presence of smallholders with both diversified (Type 1) and concentrated (Type 2) crop portfolios is more even (60 % to 40 % respectively). It is also relevant to point out that for all farm types upland rice has a dominant position in the crop portfolio with an average of 28 % of total cultivated area for Type 1, 50 % for Type 2; 20 % for Type 3 and 12 % for Type 4. The first reading from typology findings is that smallholders in Sierra Leone are inclined to manage a wide range of crops within their plots even if rice is well-recognized as the national staple crop. The latter is aligned to the widespread practice of inter-cropping in tropical and sub-tropical Sierra Leone.

In terms of social vulnerability among types, 88 % of smallholders belonging to Type 1 and 85 % of Type 2 smallholders are identified as "food poor" on the basis of the FCS threshold of 0.30 $ per person per day. Conversely, Types 3 and 4 from the rainforest ecology (or humid zone) present the lowest percentages of "food poor" smallholders (11 % and 9 % respectively). This is not surprising given the difference in average NFI per farm-household unit reported for Types 3 & 4 are roughly over 10 times higher than those reported under types 1 & 2. In order to draw accurate comparisons between types, the poverty gap index (PGI) is calculated. PGI is deemed suitable as it can be interpreted as the average percentage shortfall in income for the type population from the given threshold allowing for effective group comparisons. As illustrated, 76 % of the population of Type 2 farms are below the poor/borderline FCS expenditure threshold, making this the most vulnerable group among identified types. This is followed by 56 % for Type 1, 21 % for Type 4 and only 4 % for Type 3. Although the percentages are smaller for types in the humid zone, the findings suggest that smallholders with higher crop concentration are worse off than their counterparts in the same agroecological setting.

In terms of asset endowments Type 2 smallholders report the lowest land availability per adult equivalent household member, the lowest access to manual equipment at farm-household level and the lowest percentage of rice output sold. It is thus also not surprising that the overall output value per working unit is also the lowest for Type 2. Rice growers of the sub-humid zone (Type 2) are the poorest, rely mainly on self-consumption (for the case of rice) and have comparatively less access to productive assets. In other words, Type 2 smallholders coincide with Ellis & Freeman (2004) description of rural farm-households with low incomes which are associated with small land and livestock holdings, high reliance on food crop agriculture and low monetisation of the rural economy.

Table 3: *Identification of farm types based on two criteria*

Identification criteria, indicators & thresholds	
Agro-ecological zone	Sub-Humid zone or Lowland & Upland ecologies suitable for rice cultivation (Sub-Humid zone = 0) *or* Humid zone or Rainforest ecology suitable for coffee and cocoa cultivation (Humid zone = 1)
Crop concentration / diversification	Crop concentrated = 1, if Simpson Index > 0.5 *or* Crop diversified = 0, if Simpson Index < 0.5

Table 4: *Emerging types & descriptive information*

	TYPE 1: Sub-Humid & DIVERSIFIED	*TYPE 2: Sub-Humid & CONCENTRATED*	*TYPE 3: Humid & DIVERSIFIED*	*TYPE 4: Humid & CONCENTRATED*
Total # of obs	240	159	191	11
% of sample	39.9%	26.5%	31.8%	1.8%
% within ecology	60.2%	39.8%	94.6%	5.4%
Richness Index	16	6	12	4
Avg % rice cultivated area	28%	50%	20%	12%
Main crop in avg % area	Oil Palm: 30%	Rice: 50%	Cocoa: 33% Coffee: 22%	Cocoa: 39% Coffee: 21%
Food security & poverty				
% of smallholders below the "poor/borderline" FCS expenditure	88	85	11	9
Avg NFI per hhunit (SLL)	100,100	59,216	926,663	1,055,236
Poverty gap index	59	76	4	21
Asset endowment, market participation & output value				
Avg acre per adult equivalent household member	1.36	0.95	2.42	1.55
Avg manual equipment (# of hand tools) available at farm-household level	15.3	14.8	28.8	18.3
Avg fallow period	5.7	6.8	10.1	4.8
Avg % of rice sold	30	25	65	64
Avg output value per working unit (SLL)	883,961	601,049	1,495,987	732,000
Avg output value obtained per staple-cultivated Acre (SLL)	169,743	179,557	259,468	300,000
Avg output value obtained per cash tree crop-cultivated acre (SLL)	53,252	48,134	668,823	729,838

Note: the distribution of observations between Type 3 and Type 4 in the rainforest / humid ecology is sustained even at a threshold of HH < 0.3 suggesting that crop portfolios for smallholders able to grow cocoa and coffee are highly diversified denoting a preference for integrated staple and cash crop systems.

Type 1 farm-households in the sub-humid zone who manage diversified crop portfolios appear to be better off than Type 2 farm-households. Regarding Types 3 & 4 from the rainforest ecology, it may be argued that their involvement with cash tree crops (cocoa and/or coffee) is a strong determinant in their achievement of higher NFI levels. However, given the distribution of observations between these two types, it can be stated that the majority of smallholders in this zone tend to prefer diversified crop portfolios even if the agro-ecology is suitable for cocoa and coffee cultivation. In fact, the PGI for Type 3 is by far the lowest. Smallholders in this zone are also on average marketing a higher percentage of their cultivated rice output. The latter suggests

that a combination of staple and cash tree crop cultivation yields on average higher output value per cultivated acre. This finding fits rather well with the positive synergies emerging from mixed cropping systems as observed by Govereh & Jayne (2003). According to these authors, participation in cash crop schemes (especially under conditions of credit and input market failures) may enable smallholders to acquire key inputs and skills which can be used to increase their overall producitivty; thus exploiting synergies between cash crops and food crops not only in terms of production but also commercialy.

This typological analysis complements the econometric findings, and the combined evidence suggests that the STABEX-funded crop-specific policies partially failed to acknowledge the food security purposes of diversified crop portfolio management among targeted smallholders. For instance, the majority of smallholders have diversified plots (i.e. Types 1 & 3 representing more than two thirds of the sample). Type 3 smallholders who combine food and cash tree crop cultivation systems in the humid zone, were substantially better off than Type 4 smallholders with highly concentrated plots of cocoa and coffee. In fact, Type 4 farms were the smallest type in the sample and reported higher land limitations than Type 3, reinforcing the idea that when feasible smallholders in the humid zone prefer the mixed staple-cash tree crop cultivation system. In the sub-humid zone, rice-specific support seemed suitable to Type 2 smallholders who have on average 50 % of their plots under rice cultivation. However, this was also the group who claimed that the support was insufficient to raise income levels (Gomez y Paloma *et al.*, 2012).

4 Policy discussion

The econometric and qualitative findings suggest that STABEX-funded crop specific programs did not fully consider the implications of shifting cultivation and diversified crops at plot level which tend to be rather characteristic of tropical and sub-tropical agriculture. In fact, promoting a specific crop, even as relevant as rice in Sierra Leone, did not fulfil the expectations of particularly the poorest types of targeted farms who were actually the most reliant on this crop for self-consumption. In their particular situation, production requires to be substantially increased in order to fulfil internal consumption needs before engaging in sales (i.e. Type 2 smallholders consumed on average up to 75 % of their rice output). This situation calls for a reflection on the type of support provided for this specific segment of farms. Access to output increasing technology (for instance, fertilisers) was not central in the STABEX-funded technical assistance. Likewise, there was no emphasis on introducing sustainable land and water management approaches or supporting mixed production systems that could foster a varied diet. Smallholders did not have access to yield-increasing inputs or enhanced natural resource management. Actually, STABEX-funded initiatives were limited to rice market information, consolidation of farmer groups and training rather than efforts to increase actual productivity. The subjective evaluation of Type 2 smallholders concerning these initiatives suggests that a more balanced approach (which could have promoted both production and commercialisation) would have likely been more welcome. Similarly, a focus on systems of production (with diversified crops) could have been more aligned to smallholder food security concerns.

The situation for smallholders in the rainforest ecology (mainly Type 3 farm-households who represent the majority in this zone) is illustrative of the benefits associated to mixed agricultural systems (i.e. cash and food cropping). There are important indirect effects of cash cropping on the productivity of food cropping. Govereh & Jayne (2003) have classified two potential pathways by which these benefits occur: *farm-household-level synergies*, in which a farmer's participation in a commercialised crop scheme enables the acquisition of resources that would otherwise not be accessible for use on other crops and *regional spill-over effects* which occur when a commercialisation scheme attracts new investments to a region thereby providing benefits to all farmers in that region, regardless of whether they engage in the commercialisation of the given cash crop. According to Govereh & Jayne (2003) cash generating crops can help farmers overcome capital constraints on the purchase of lumpy assets and inputs, which can be used to expand food crop as well as cash crop production. In this setting, the STABEX-funded initiatives aimed at improving grade and standards (as well as international regulation enforcement) had a positive impact on price levels of cocoa and coffee grains aimed at export markets.

Crop diversification can also be seen as a path to break the cycle of rural poverty where smallholders are characterised by declining land availability, food deficit from own production, low monetisation of the local economy and little cash circulation to multiply rural activities (Ellis & Freeman, 2004). It is also relevant to remember that although farming systems of most regions are usually described in terms of a small number of crops, the majority of farming families, however, grow a

wide variety of crops. Inter-planting two, three or more crops is widespread. Crop diversification also ensures a more effective use of aerial space. Crops are sometimes partly complementary in nutrient requirements, it minimises the effects of pest and disease attacks, combined yields are usually higher than the yields of individual crops and the soil is covered for a longer period by the combination of crops. Lastly, crop diversification is considered an important initial step in the transition from subsistence to commercial agriculture (Losch *et al.*, 2012).

But, if the benefits of crop diversification are so varied and to a large extent suitable to the agricultural environment of Sierra Leone, why were STABEX-funded initiatives focused on crop-specific support? From the part of the EU, there is strong commitment to frame development cooperation in line with the principles of ownership and partnership (EC, 2011). Dialogue at country level determines exactly where and how the EU intervenes.

According to Rodenburg *et al.* (2006), Sierra Leone's agricultural development policy has focused since independence on the achievement of rice self-sufficiency. Rice provides more proteins than cassava, maize or sorghum, it is available all year round because of its long shelf life (provided adequate storage is in place), making it preferable to other crops for food security (Norman & Kebe, 2006). Rice production also offers an important source of employment during cultivation, post-harvest and commercialisation. In Sierra Leone, rice is accepted as a medium of exchange and it drives the barter economy, often being used to procure coffee and cocoa, lure labour and purchase farm inputs and wage goods (*ibid.*). One important downside is that national-level specialisation in a given crop puts higher pressure to maintain a stable policy environment, to engage in WTO negotiations which safeguard the country's competitive position as well as to improve contract law (Kelly *et al.*, 2003). Another constraint surrounding rice production is the limited scope for area expansion under the traditional bush fallow system. As a result, most of the productivity increases must come from yield improvements which require the adoption of new technologies by the smallholders who produce the bulk of agricultural output (Rodenburg *et al.*, 2006). In this respect, STABEX-funded initiatives included a strong training component that may have had stronger effects if accompanied by adequate physical access to yield increasing technology (mainly fertilisers and improved seeds or machinery).

The National Sustainable Agriculture Development Plan of Sierra Leone (NSADP, 2009) focuses on a move towards permanent cultivation of food crops (mainly rice and cassava) and promotion of export tree crops (i.e. cocoa and coffee). In the case of smallholders that due to agro-environmental conditions cannot grow traditional export trees such as cocoa and coffee, the diversification of staple crops at plot level appears to be a dominant practice in comparison to mono-cultivation; if sufficient productive resources are available (namely, both labour and land). The main challenges for the implementation of the NSADP are on one hand the transition period between shifting cultivation systems to permanent agriculture and on the other the sustainability of the newly adopted system (Saravia-Matus & Gomez y Paloma, 2015). In the first matter, effects on short-term food security and employment opportunities must be considered. In the second, market organisation is crucial (particularly for the supply of key inputs such as fertilisers, improved seeds, pesticides or machinery).

In summary, the government's request for STABEX funds were guided by NSADP principles and the long term objective of securing and maintaining rice self-sufficiency as well as the promotion of key agricultural exports (i.e. coffee and cocoa). The EU funds were thus aimed at basic training (in the cultivation of selected crops according to the targeted zones), the provision of market information and the consolidation of farmer groups. Clearly, these aspects are relevant for the transition from shifting cultivation to permanent cultivation. However, these efforts are insufficient to tackle poverty reduction and food insecurity of smallholders.

The literature on agricultural development policies in sub-Saharan Africa is extensive and a great variety of interventions can be identified, yet in most cases these are not related to specific crops or to choosing winning crops. The latter can actually be classified into two main groups which roughly relate to *failures of production* on one hand and *failures of exchange and response* on the other hand (Devereux, 2009):

(i) *Addressing failures of production*: Most of the initiatives to increase production are usually connected to the improvement of natural resources management. These include tasks to enhance soil fertility (with adequate training in the fertiliser use and access), water access and management (irrigation facilities and water control) or improved seeds and fertilifers (natural or chemical). According to Jama & Pizarro (2008) in Africa only a small proportion of farmers use fertilisers and the amounts used are often inadequate. On average each hectare receives less than 9 kg of nitrogen and 6 kg of phosphorus. Typical crop requirements per hectare are at least 60 kg of nitrogen and 30 kg of phosphorus.

Chemical fertiliser use per hectare of farmland in Africa is about 10 % of the world's average, by far the lowest. It is important to highlight that the provision of fertilisers was not among the key activities of the STABEX-funded programs and it was one of the most frequent complaints of the targeted smallholders (Gomez y Paloma *et al.*, 2012). The same applies for the case of access to improved seeds. According to Norman & Kebe (2006) the low agricultural productivity in West and East Africa is due to an important extent to high incidence of pests, weeds, and diseases, drought and poor water control, poor seed management, poor soil fertility management and the necessary labour requirements to conduct efficient sustainable management of natural resources.

(ii) *Addressing failures of exchange and response*: initiatives to enhance institutional coordination and align incentive structures are often connected to the improvement of market access (both in terms of output and inputs markets including credit), extension services (training, weather forecasts, technology, etc.) and rural infrastructure. According to Barrett (2008) smallholders face two types of market entry barriers. One entry barrier is found at the micro-level where smallholders face insufficient access to productive assets, financing and improved production technologies which may generate adequate marketable surplus and make market participation feasible. The other entry barrier takes place at the meso-level. In remote areas the high costs of commerce limit market access (both in terms of spatial price transmission and trader competition). The latter leads to thinner and more volatile markets limiting smallholders' incentives to increase productivity so as to generate marketable surpluses. Agricultural productivity growth depends on functioning input distribution systems and *vice versa* (Jama & Pizarro, 2008) as well as on reliable infrastructure (i.e. roads, storage facilities, electrification) (Kelly *et al.*, 2003). Similarly, farmers need to be aware of what technologies work best, know how to use them and generate effective demand for viable new technologies to provide signals to input distribution system to supply them (*ibid.*). The STABEX-funded initiatives were not focusing on securing input provision networks; instead attention was placed on the consolidation of farmers' associations in order for them to create a demand for productive inputs as well as to organise selling channels. However, the reduced yields and the internal consumption requirements served as barriers for these efforts to be entirely effective. The STABEX-funded initiatives were aimed at reducing the costs associated to accessing markets by providing price information but no particular efforts were targeted at increasing productivity beyond training. Similarly, the development of public infrastructure was not a priority under STABEX-funded interventions. As highlighted by Kelly *et al.* (2003) without commitment to providing basic public goods, large scale government input subsidies, credit access or distribution programs are unlikely to have any lasting impact on agricultural intensification, rural incomes, national food security and poverty reduction. Consequently, governments need to also focus on public goods as a pre-requisite that will encourage farmers to intensify agricultural production and encourage the private sector to expand commercial input supply.

5 Conclusions

The present case study has provided evidence of the various agronomic and socio-economic strategies that farmers can adopt in order to improve their food security, considering their agro-ecological settings and market constraints. In Sierra Leone, such strategies were mainly related to crop diversification and self-consumption orientation. However, EU-funded aid policy measures on food security in Sierra Leone followed a crop-specific support mechanism as a mean to enhance production and market participation. The main idea behind this crop-specific support is that enhanced market interactions would increase incentives to expand rice, cocoa and coffee production thus lifting NFI and procuring a positive effect on food security.

Although rice is without doubt a key staple crop, the majority of targeted smallholders held diversified crop portfolios. At the same time, the strong reliance on agricultural output to fulfil self-consumption needs partially diminished the potential positive effects of policies aimed at increasing output market interactions. In fact, the poorest smallholders were the ones reporting strong specialisation and self-consumption in rice. On the other hand, smallholders with mixed agricultural systems of both cash tree crops and staple crops seemed to achieve higher food security levels on the basis of their achieved NFI. The agricultural development literature suggests that a series of positive synergies emerge between export crops and domestic food crops which allow increasing both productivity and market integration.

One of the key lessons of the Sierra Leone case study for both national officials and international donors is that in order to achieve food security, failures of production, exchange and response, have to be jointly addressed in a balanced manner. In Sierra Leone, the government favoured a crop-specific approach aimed at improving commercialisation, thus targeting the exchange failure aspect. An in-depth analysis of the con-

strained environment in which smallholders operate reveals that without addressing the obstacles to production enhancement (which needs to first cover substantial self-consumption needs) effective market responses will not develop. Similarly, a private input distribution network will not emerge if farmers are first interested in fulfilling their self-consumption requirements rather than integrating into output markets. Also, aid programs may largely increase their impact by focussing on the role of public investment in key assets and infrastructures. Efforts to provide training for improving market understanding and access, organisation of farmers' groups and even crop specific techniques are insufficient if access to yield increasing technology is not secured along with adequate establishments for storage and suitable transportation (both in terms of rural roads and machinery).

The latter calls for a more in-depth analysis of the various policy interventions directed towards a given agricultural area or areas. It is necessary to first account for all existing programs and assess the potential interlinkages and set of incentives that are being transmitted to targeted farms. In the particular situation of Sierra Leone, donor interventions such as that of the EU Aid policy are well aligned to the National Sustainable Agriculture Development Plan (NSADP) which the Government of Sierra Leone launched in 2009. The NSADP which is currently under implementation (2010–2030), proposes the gradual eradication of shifting cultivation practices and the active promotion of vertically integrated processing and marketing chains for selected staples (mainly rice and cassava) and export crops (cocoa and coffee). According to Saravia-Matus & Gomez y Paloma (2015), the government will have to create substantial transaction benefits to promote crop-specific commercialisation in the main agricultural areas of the country. These benefits should be accompanied by an overall incentive package that addresses the entire rural economy in Sierra Leone, otherwise, smallholders highly dependent on diversified crop portfolios for self-consumption will not be adequately accounted for in the NSADP.

Slow growth in agricultural productivity and income translates into slow overall economic development and increased poverty. Although agricultural investment and support continues to be an indisputable measure to achieve food security, the main recommendation emerging from the Sierra Leone experience with EU aid resources is that interventions need to be balanced and adapted to the agricultural and institutional context in which smallholders operate. Similarly, it is important to further analyse the interlinkages across existing policy interventions and plans. Only focusing on production enhancement without adequate market integration will prove deficient, in the same way that the opposite approach will not be enough to create incentives for expanding agricultural output, particularly when poverty and food insecurity are as severe as in the case of rural Sierra Leone and its agricultural setting.

References

Barrett, C. B. (2008). Smallholder market participation: Concepts and evidence from eastern and southern Africa. *Food Policy*, 33, 299–317.

Baum, C. F. (2006). *An Introduction to Modern Econometrics Using Stata*. Stata Press Publication, Texas, USA.

Coelli, T. J. & Fleming, E. (2004). Diversification economies and specialisation efficiencies in a mixed food and coffee smallholder farming system in Papua New Guinea. *Agricultural Economics*, 31 (2–3), 229–239.

Devereux, S. (2009). Why does famine persist in Africa? *Food Security*, 1, 25–35.

EC (2011). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Increasing the impact of EU Development Policy: an Agenda for Change. European Commission (EC), Brussels, 13 October 2011.

Ellis, F. & Freeman, H. A. (2004). Rural livelihoods and poverty reduction strategies in four African countries. *The Journal of Development Studies*, 40 (4), 1–30.

Even, M. A., Saravia-Matus, S., Giovannetti, J. F. & Groppo, P. (2016). The WAW International Typology as a Mechanism to Monitor Agricultural and Rural Transformations. *Development*. doi:10.1057/s41301-016-0001-9.

FAO (2008). Interagency Workshop Report WFP – FAO Measures of Food Consumption - Harmonizing Methodologies. FAO, Rome, 9 - 10 April 2008.

FAO (2010–2011). *The State of Food and Agriculture (SOFA): Women in agriculture: closing the gender gap for development*. FAO, Rome, Italy.

Gomez y Paloma, S., Acs, S., Saravia-Matus, S., Lakoh, A., Michel, B., Hites, G. & Sammeth, F. (2012). Rural poverty reduction and food security: The case of smallholders in Sierra Leone. EC-JRC-IPTS Technical Report EUR Number: 25264 EN. Seville, Spain.

Govereh, J. & Jayne, T. (2003). Cash cropping and food crop productivity: synergies or trade-offs? *Agricultural Economics*, 28, 39–50.

Government of Sierra Leone (2007). Prospects for the Poor in the Face of National Agriculture Reforms: A Poverty & Social Impact Analysis of Changes to Agricultural Policy in Sierra Leone. Economic Policy and Research Unit, Ministry of Finance. May 2007.

Jama, B. & Pizarro, G. (2008). *Agriculture in Africa: Strategies to improve and sustain smallholder production systems*. UNDP. New York Academy of Science, N.Y.

Jayne, T. S., Haggblade, S., Minot, N. & Rashid, S. (2011). Agricultural Commercialisation, Rural Transformation and Poverty Reduction: What have We Learned about How to Achieve This? Synthesis report prepared for the African Agricultural Markets Programme Policy Symposium, Alliance for Commodity Trade in Eastern and Southern Africa April 20–22, 2011, Kigali, Rwanda.

Kelly, V., Adesina, A. A. & Gordon, A. (2003). Expanding access to agricultural inputs in Africa: a review of recent market development experience. *Food Policy*, 28, 379–404.

Losch, B., Fréguin-Gresh, S. & White, E. T. (2012). *Structural Transformation and Rural Change Revisited: Challenges for Late Developing Countries in a Globalizing World*. World Bank, Washington D.C. 277 pp

Lovendahl, R. C. & Knowles, M. (2005). *Tomorrow´s Hunger: A Framework for Analysing Vulnerability to Food Insecurity*. FAO-ESA Working Paper No. 05-07. Rome, Italy.

McCarthy, N., Lipper, L. & Branca, G. (2011). *Climate-Smart Agriculture: Smallholder Adoption and Implications for Climate Change Adaptation and Mitigation.* Mitigation of Climate Change in Agriculture Series 4. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Norman, J. C. & Kebe, B. (2006). African smallholder farmers: rice production and sustainable livelihoods. Regional Perspectives. *International Rice Commission Newsletter – Regional Perspectives*, 55, 33–42.

NSADP (2009). *National Sustainable Agriculture Development Plan 2010–2030*. The Republic of Sierra Leone.

Ragasa, C. (2012). Gender and Institutional Dimensions of Agricultural Technology Adoption: A Review of Literature and Synthesis of 35 Case Studies. International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil 18-24 August, 2012.

Rodenburg, J., Diagne, A., Oikeh, S., Futakuchi, K., Kormawa, P. M., Semon, M., Akintayo, I., Cissé, B., Sié, M., Narteh, L., Nwilene, F., Diatta, S., Sere, Y., Ndjiondjop, M. N., Youm, O. & Keya, S. O. (2006). Achievements and impact of NERICA on sustainable rice production in sub-Saharan Africa. *International Rice Commission Newsletter – Regional Perspectives*, 55, 45–58. FAO, Rome

Saravia-Matus, S. & Gomez y Paloma, S. (2014). Farm Viability of (Semi) Subsistence Smallholders in Sierra Leone. *The African Journal of Agricultural and Resource Economics (AfJARE)*, 9 (3), 165–182.

Saravia-Matus, S. & Gomez y Paloma, S. (2015). Implementation challenges to the National Sustainable Agriculture Development Plan (NSADP) for (semi)subsistence farmers in Sierra Leone. *Cahiers Agricultures*, 24 (4), 240–245. doi: 10.1684/agr.2015.0757.

Saravia-Matus, S., Gomez y Paloma, S. & Mary, S. (2012). Economics of Food Security. *Bio Based and Applied Economics Journal*, 1 (1), 65–80.

Solis, D., Bravo-Ureta, B. E. & Quiroga, R. E. (2008). Technical Efficiency among Peasant Farmers Participating in Natural Resource Management Programmes in Central America. *Journal of Agricultural Economics*, 60 (1), 202–219.

Unruh, J. D. & Turray, H. (2006). Land tenure, food security and investment in post-war Sierra Leone. LSP Working Paper 22, Access to Natural Resources Sub-Programme, FAO.

World Food Program (2008). *Sierra Leone: Household Food Security Survey in Rural Areas*. World Food Programme, Vulnerability Analysis and Mapping Branch (ODAV). Data collected in May 2007