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FOOD AND ENTERPRISE DEVELOPMENT (FED) PROGRAM FOR LIBERIA

SUB-TITLE: LIBERIA URBAN AND PER-URBAN
HORTICULTURE SECTOR; GAPS ASSESSMENT
AUTHOR: DERMOT CASSIDY

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ACRONYMS

| | |
|-------------|---|
| BRAC | Bangladesh Rehabilitation Assistance Committee |
| ECOW AS | Economic Community Of West African States |
| FAO | Food and Agriculture Organization |
| FED | Food and Enterprise Development (Project) |
| LAUNCH H | Liberian Agricultural Upgrading, Nutrition and Child Health |
| MoA | Ministry of Agriculture |
| NGO's | Non Governmental Organizations |
| SPS | Sanitary and Phytosanitary |

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Executive Summary

Liberian horticulture is smallholder based with minimal inputs and localized marketing channels. While there is an immense amount of local knowledge derived from generations of trial and error in practical horticultural production. The sector has lagged behind those in other countries in the region.

The situation is promising in that there is an immense amount of slack to be taken in with a high potential for significant impact. The gaps study identifies a range of targeted interventions to;

1. Carefully identify the production and marketing bottlenecks along the value chain using a variety of scientific, and other analytical approaches.
2. Target interventions where these are identified as limiting, and where intervention costs are economically justified.
3. Ensure that intervention costs can be met by the various actors in the value chain.

The entire horticultural value chain in Liberia is characterized by what can best be described as a continuous bottleneck so it is very important for the USAID Food and Enterprise Development Project (FED) to ensure that the constraints are met holistically rather than piecemeal, and in close collaboration with the Ministry of Agriculture and other donor projects.

Introduction

The horticulture sector in Liberia is characterized by the nature of production which is smallholder based. The climate of the FED project area is primarily a tropical monsoon climate (Am in the Köppen classification) with a relatively short dry season soon after the "winter" solstice i.e. the four months after the third week in December which poses several challenges. These include crop protection, post harvest physiology, logistics, and dry season inputs including the need for irrigation. These problems are coupled with an almost total lack of published information on every aspect of horticultural production in Liberia.

Methodology

The methodology used in this analysis is driven by the value chain approach using a matrix format as shown in Figure 1. The basic division is that of looking at the general enabling environment at the top, the detailed subdivisions of value chain, and the various actors at the bottom. The first group i.e. those in the enabling environment, are generally the government regulators and support services. A summary of the results of the analysis are shown in Appendix I.

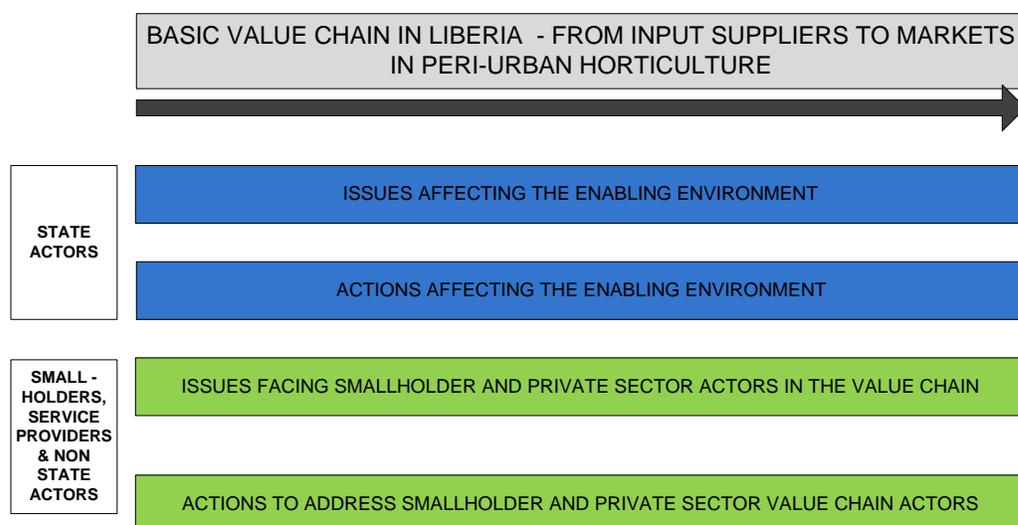


Figure 1; Basic methodology for the gaps analysis for horticulture value chain in Liberia

The basic structure of this study follows that of the matrix by first looking at the enabling environment, and then the value chain itself starting with services, input providers, and finishing off with consumers.

The Enabling Environment

Control exercised by the Government of Liberia over agriculture is somewhat rudimentary. In a sense this is an advantage as the Food and Enterprise Development Project is in a position to influence and shape this area of government. In the short term, constructive engagement with the government will ensure less in the way of difficulties in issues such as the importation of inputs such as seed, and agrochemicals. The following issues exist;

1. There are no clear guidelines on the importation of plant materials (vegetative and seed). This is primarily because there is no national pest list for Liberian horticultural crops.
2. Liberia has no list of registered agrochemicals for crop use. Proposed/actual rules are the general Food and Agriculture Organization (FAO) guidelines on pesticide registration. However, there is no list of approved agrochemicals for Liberia, crops they can be applied on or such things at application rates and with-holding periods.
3. Requiring formal registration is likely to lead to a withdrawal of most agrochemicals as the size of the market is unlikely to justify the costs of registration.
4. There is no local formal Sanitary and Phytosanitary (SPS) support mechanism. The lack of SPS is of minor concern at the moment, as there is no real prospect of significant horticultural exports from Liberia in the near future.
5. Most countries have a national register of approved crop cultivars. There does not appear to be one for Liberia.

Enabling environment; actions

1. FED can assist the Government of Liberia in drafting up internal guidelines for seed and vegetative plant material procurement in consultation with the National Plant Protection Organization in the Ministry of Agriculture
2. Pesticides; the issue is likely to be quite important in respect of horticultural diseases. Even in the current dry season foliar diseases are quite significant, and a range of control measures will be necessary. In particular, the problems posed by the downy mildews are likely to be significant.¹ Therefore, it will be necessary to ensure that regulations and pesticide lists are allow for ease of registration of an inclusive list of agrochemicals. A way forward may be to use registrations from Economic Community Of West African States (ECOWAS) countries with good working registration programs and similar climates. and to allow companies to present data used in registration in those countries for extending the registration to Liberia – e.g. Ghana and Nigeria.
3. FED is starting a program of pest and disease identification on horticultural crops. This can be supervised by the Ministry of Agriculture as part of their crop pest listing, and as a necessary first step in protecting local horticulture from the potential for introducing new pests, and diseases.
4. FED can help the National Plant Protection Organization of Liberia draft policy documents relating to support for horticultural production.

Input Suppliers

As discussed above input suppliers operate in a policy, and regulatory vacuum. This can often lead to the incorrect application of inputs including non adapted crop cultivars, incorrect and inappropriate pesticides and fertilizers in terms of availability, and technically driven advice among other issues.

Input suppliers also operate in the ignorance of the specific requirements of crops, pests and disease pressures, crop water requirements, as well as appropriate and adapted cultivars. The only available fertilizer is a ‘take it or leave it’ combination of NPK 15:15:15 and urea. While

¹ i.e. Oomycota causing diseases such as late blight in tomatoes

one could perhaps, in the short term, live with a single compound fertilizer the fact is that urea is totally unsuitable for horticulture.²

Other inputs include access to water through irrigation and other equipment, plant production (nurseries), and access to finance.

Input suppliers; actions

Input suppliers should back up their product range with the following;

Availability of suitable seed – a major issue. Most seed used by smallholders is self saved and of poor quality. While self saving is not necessarily a bad idea even when seed is commercially available there appear to be several problems which could be attributed to poor seed quality. Project requirements are for the following types of seed;

1. Bitter ball (*Solanum incanum*)
2. Chili (*Capsicum annuum* and/or *C. frutescens*) especially virus resistant types
3. Collard greens (*Brassica oleracea* var. *acephala*)
4. Amaranthus spp. (small trials)
5. Shallot (*Allium cepa* var. *ascolonicum*)
6. Tropically adapted bulbing onions (*Allium cepa*)

Other seed types include open pollinated types of okra, tomato and egg plant which are also in short supply and (virus) indexed sweet potato vines. Of the latter the orange fleshed types appear not to be available in Liberia.

Soil testing, or failing that, soil water testing services to ensure that they are giving appropriate recommendations for the use of their product.³ It is likely that there already is a range of nutrient deficiencies in crops in Liberia partially masked by the general range of other stresses on plant growth so that the application and correction of macronutrients is likely to run up against other nutritional limiting factors. Training should be provided to fertilizer suppliers in how to market their product based on crop nutrient requirements and perhaps on some basic analysis.

Agrochemicals; more complete knowledge of the interaction of crop chemicals, and naturally occurring beneficial organisms. It is striking to note that secondary pests such as whitefly, leaf

² Urea is the only available nitrogenous topdressing in Liberia. Ideally calcium nitrate is used for topdressing horticultural crops but LAN (lime ammonium nitrate) is an acceptable substitute. The problem with urea is that it converts to ammonia in the soil which as a cation is taken up in preference to calcium by the plant. Blossom end rot is already a problem in melons due to hot dry conditions in the dry season in Liberia even without urea top dressings. The nitrogen not taken up as ammonia is converted in the soil to nitrate which is good in itself, but the process acidifies the soil leading to a host of other problems including aluminum toxicity.

³ Fertilizer suppliers could perhaps be persuaded to be more sophisticated in the range of products they provide including micronutrient 'straights' such as zinc, and boron and soil amendments such as gypsum. Given the unsophisticated nature of the Liberian horticulture sector this may remain aspirational at the moment. There are examples of more sophisticated fertilizer input providers in Kenya and Tanzania, and pre 2000 in Zimbabwe, where, however, the main driver may be the commercial farming sectors. However FED can lead the way in identifying the type and nature of fertilizers needed for high output horticulture systems.

miner, red spider mites and thrips are widespread in most horticultural crops in the country but at sub economic thresholds. This state of affairs could be quickly turned around, to the disadvantage of FED, if the indiscriminate use of persistent synthetic pyrethroids occurs. It is unfortunate that these particular agrochemicals are the most widely available and the first choice provision of agrochemical suppliers for providing to smallholders due to their initial spectacular knockdown effect. Therefore it will be necessary to train agro-chemical suppliers on how to provide a fully integrated solution to their customers and to be aware of the dangers of broad spectrum control measures.

Affordable irrigation; the issue of affordable irrigation is crucial as a poverty reduction strategy. In essence, access to water so as to extend and intensify vegetable production during the relatively dry season between January and May allows smallholders to access in turn higher value markets that are relatively poorly supplied during those months. The issues and remedies are discussed I Appendix 2.

Drying is covered in Appendix 3. The fact is that the quality of dried product in Liberia is poor. The main items seen in the market are various types of dried chilies which are both expensive and show signs of moldiness and thus is likely to contain mycotoxins.



Figure 2; Seedling production at a peri-urban site – failure caused by lack of water



Figure 3; Professional seedling production where producer has ready access to water

Plant nurseries; Appendix 4 describes the necessity to work with more professional plant nurseries. In fact a crucial issue is a combination of attention to detail and access to water. Generally this activity is carried out by specialist producers that are able to produce the correct type of planting material (small hard leaves, large root mass, free of pests and disease). While untutored producers can struggle to run an effective nursery especially where water is limited (Figure 1) there are other in the country who are relatively successful (Figure 2).

Technical knowledge; the basic knowledge of crop management is not well developed by persons even relatively well qualified in this field in Liberia. Discussions generally stop at the level of general crop production and knowledge of details of pests, diseases crop physiology, soil management, and irrigation scheduling and production planning are not part of the background of many persons operating in the field. It will be necessary to develop and provide manuals and training materials in these areas – generally from scratch for use by both the FED extension agents but also more generally by government extension workers and other workers in the field.

Access to finance; while business studies are a popular topic of study in Liberia this appears not to extend to agri-business. Finance service providers, input suppliers and growers need to be able to determine some of the basic information needed to generate a partial budget for an investment – such as buying a pump for the dry season. To do this will require FED to be able to provide information on the benefits of any given investment and train potential investors and microfinance institutions how to develop appropriate business plans and lending instruments for growers. In addition, input providers should be developed to be able to sell equipment, such as pumps, on lease or hire-purchase terms.

Other crop inputs need to be generated at the farmer level including affordable crop coverings such as mulches, soil amendments such as compost, traditional, and alternative crop protection. This may, for instance, be by training growers to make ‘compost teas’ using 44 gallon drums purchased for the purpose.

Producers

As discussed in this and other sections of this analysis growers are largely operating in a technical vacuum. They lack leads on to significant gaps for growers in a range of issues including an inability to make correct decisions on a wide range of issues including;

1. Basic agronomy including crop planning, agronomy, pest and disease management, and marketing.
2. Ability to find input suppliers, and to interact with them in an informed way.
3. Access to markets is limited by poor logistics – even for producers close to urban centers. Lack of access really limits marketing to very short distances excepting dried product and items such as onions and cabbage.⁴

Producers; actions

Information educational materials; it is already apparent that growers have arrived at their current state of knowledge through trial and error. In many cases this has led to fairly sustainable practices such as a reasonable working relationship to pest and disease management. However intensification of crop production needs to be accompanied by a carefully considered application of additional inputs. The way forward here is careful crop choice, a full analysis of crop needs based on yield potential, the pest and disease complex as it applies to Liberia. The results of such an analysis should be developed as a series of detailed crop guides from which can be derived educational materials tailored to farmers. In itself this exercise will be a specific gaps analysis for the horticultural crops in the FED project.

Information – pests and diseases and soil analysis; a pest and disease list for horticultural crops in Liberia do not exist. A major initial activity will be the collection and identification of pest species and beneficial organisms in Liberia to inform the development of integrated Pest Management systems. Similarly cheap, low cost and rapid soil testing services will be used to ensure that growers are not missing basic options such as undiagnosed nutrient deficiencies.

⁴ Although interest is high, there appears to be very little onion production in Liberia. Most onions in Liberian produce markets seem to come from Ivory Coast, which may in turn be from further afield in Burkina Faso and Niger and transiting through the Ivory Coast.

Access to inputs that can be applied on-farm; growers are largely unaware of the potential for producing their own inputs. These can include the use of *Crotalaria junco* (sunn hemp) and *Mucuna pruriens* var *utilis* (velvet beans) which growers can reproduce for themselves, and which will control nematodes, as well as add nitrogen and biomass to the soil. Other inputs could include mulch, compost/compost tea and other natural control agents such as Vetiver and Neem oil.⁵

Financial literacy; as described in the previous section growers need to be able to determine the value of investments such as in irrigation through partial budgeting, and their development into business plans suitable for financing. This requires not just the costs of the investment but also the needed knowledge of any benefits that will flow in terms of yield, price, seasonality etc.⁶

Production planning; this is a significant gap both within FED itself as well as producers and needs to be addressed immediately. Essentially production planning is a market driven exercise that moves quickly from identifying production/marketing periods and moves to ensuring that these are accomplished. It is an action tool and not a discussion. The basic tool is the GANTT chart such as that shown in Figure 4. All growers should be trained in this technique to ensure that inputs are procured, and activities are completed on time. It should serve as a clear guide for FED extension workers as a check of weekly activities and reports. Also important on production planning is the choice of what crops to select. Okra, a close relative of cotton, is simply hopelessly inundated with a wide range of pests and diseases and should not be a part of any cropping plan in the immediate future though as more experience of pest and disease management is developed within FED it would be a very viable high value option.

⁵ There are many such options for natural control products and those cited in the text are merely examples.

⁶ Determining the financial viability of processing activities can be even more challenging especially for commercial operations including the purchase and storage of fresh produce for processing and sale. Service processing i.e. the processing fresh produce of others for a fee or a portion of what is eventually processed – is a lot easier.

| Date | | 13-Feb | 20-Feb | 27-Feb | 5-Mar | 12-Mar | 19-Mar | 26-Mar | 2-Apr | 9-Apr | 16-Apr | 23-Apr | 30-Apr | 7-May | 14-May |
|-------------------------|-----------------|----------|--------|--------|-------|--------|--------|--------|-------|-------|--------|--------|--------|-------|--------|
| Month | | February | | | March | | | April | | | | May | | | |
| Week | | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Start of main rains | | | | | | | | | | | | | | | |
| Site selection | | | | | | | | | | | | | | | |
| Preparation of seedbeds | | | | | | | | | | | | | | | |
| Sowing | | | | | | | | | | | | | | | |
| Growth in Seed bed | | | | | | | | | | | | | | | |
| | First clipping | | | | | | | | | | | | | | |
| | Second clipping | | | | | | | | | | | | | | |
| Transplanting | | | | | | | | | | | | | | | |

Figure 4; Production planning GANTT for rainy season pepper production in Liberia (draft for illustrative purposes)

Traders and Logistics Providers

Traders and logistics providers are an essential part of the value chain. In general it appears that there is a deeply limited service in this area. Visits to markets explain this finding – generally the availability of horticultural crops in markets show that quantity and quality is very poor and prices are very high (a dry season finding which may well be different in the rainy season).

Without significant volumes of crops for sale traders in horticultural products – from country traders buying directly off the growers to those selling in the various markets will struggle to make ends meet – even with high margins. The options for linking up with commercial farmers in Liberia are very limited so it may be that grower groups may - at some point in the FED – project - be encouraged to aggregate their production through some form of marketing point near their smallholdings.⁷ This may simply take the form of a covered slab. Simple cold chain could possibly be introduced at a later point through wet wall charcoal cooler rooms – environmental considerations permitting.⁸

However the provision of these services pre-supposes a volume and continuity of product to justify the investment. The usual driver for this sort of investment is an existing need for the service rather than the other way round.

Processors

Some of the options for processing are covered in Appendix 3 –Drying. In general, processors purchase their raw material inputs at below fresh market prices even if the final product is quite expensive so this is not a value added option for growers. It may be possible that the proposed dryers might be used as service units serving producers in the vicinity for the drying of their produce. A particular gap is the knowledge within FED, and Liberia in general, in options for processing. Obvious possibilities include chili sauces but if the value chain list is widened, for example, to include mango then other ideas such as mango achar which uses the green immature fruit as a raw material are a possibility. However, most of the vegetable products will be marketed fresh, so processing options are limited possibility at the moment.

⁷ There seems to be a strong preference for direct marketing by growers in Liberia so the advantages of developing relationships with processors, vendors, and country traders needs to be demonstrated

⁸ A bricks and sand cool chamber might be more environmentally acceptable and just as effective. This might cost \$200 to \$300 and hold 200 kg of produce.

Domestic Retailers

Very few growers have access to retailers in Monrovia. Specific it is difficult for smallholders to access market share of retail chains. Market access is a significant issue for all smallholders participating in the FED Project.

Domestic retailers; actions

Linkages; in the short term there is little that can be done in this area. Supermarket access will be a function of continuous supply of consistent quality produce, and not the soliciting of contracts to supply. Therefore the initial focus by default will be on the two lower links in the supply chain (input providers and producers). Some possible marketing and processing links have been identified once smallholders have been brought up to speed.

Exports

There are no realistic options for the formal export of vegetables from Liberia at present. It may be that onions could perhaps be sold in surrounding countries, but this is merely speculation at this point.

Consumers

A particular gap in respect of consumers is that of determining their needs and preferences. Needs would include nutritional as well as dietary preferences. It is not clear at this point what the nutritional gaps in the Liberian diet that FED could fill.

Consumers; actions

The Liberian diet includes a significant vegetable component such as cassava and sweet potato leaves, so it needs to be determined exactly what FED will do to dietary diversity and nutritional indicators

Conclusions

The actions and gaps that need to be filled in respect to the value chain are covered in the various sections in the text above. These provide, in effect a detailed rational checklist generated in the Value Chain table in Appendix I. This section makes a few general points in terms of general gaps.

Nutrition and diet trends in Liberia

Currently, FED knows about the vegetable sector in Liberia is the markets for fresh and dried vegetables are growing as urbanization, and incomes increase in Liberia. Demand is increasing at least as fast as the country's rate of urbanization. Taste changes that typically occur in urban settings, and increasing incomes are pushing the market for vegetables to increase further. For some crops (e.g., bitterball, okra, eggplant, watermelon, and cabbage), demand is being met primarily by local production. For other crops (e.g., pepper), demand is being met by a combination of local production and imports. For example, a significant percentage of dried peppers are imported to Guinea where conditions for sun-drying are more favorable than in Liberia. For still others (e.g., bulb-onions), demand is being met primarily by imports, although the potential appears to exist for some degree of local production of these crops. Under similar agro-climatic conditions, neighboring Ivory Coast for example produces a significant percentage of the onions that it consumes.

What also can be said with some confidence is that there is a considerable scope for the introduction of improved production, and post-harvest processing practices and technologies will allow Liberian producers to better meet the national demand for vegetables, and to eventually aspire to supplying the regional export markets found in Guinea, Ivory Coast, and Sierra Leone.

However, detail is lacking in regard to the growth potential of the sector in terms of market surveys consumption trends, markets, consumption, prices, etc. A significant effort to either carry out this study during the course of the FED project or to link up with other similar studies being conducted by other analysts is needed output for the project.

Other donors

There is considerable interest in the sector from the donor community as well as the Government of Liberia (through the Ministry of Agriculture). There are a number of existing known current interventions and plans; Ministry of Agriculture (MOA), non-Governmental organizations (NGOs), private sector, etc, on what they are doing, what they are planning to do. The following interventions are ongoing or planned by the donor community;

1. CARE and Welthungerhilfe (formerly German Agro-Action) are promoting urban and peri-urban mostly leafy vegetable production.
2. Bangladesh Rehabilitation Assistance Committee (BRAC) promotes seedling production and sales as well as commercial vegetable seed production.
3. ACDI/VOCA also promotes vegetable production.
4. The private sector supplies some poorly researched inputs, including seed, fertilizer, insecticides, and fungicides; these include Green Field, Weinco Agriculture, and Miagro.

5. MOA coordinates the activities of the various vegetable value chain actors.
6. The World Bank has commissioned a study of the horticulture sector and may be planning an intervention in the near future.

However, detail is lacking and care must be taken to ensure that FED's horticulture VC program is fully communicated to the Ministry of Agriculture and to others in the donor community. A new project in peri-urban agriculture managed by ACDI/VOCA is underway and FED need to ensure that there are no overlaps with them, and that any potential synergies with other donors are fully captured to avoid overlapping. Some details of similar projects are given in Appendix 5.

Knowledge gaps and additional analysis

Development Intervention gaps; potential FED activities to address perceived gaps.

As described in more detail FED will undertake the following:

1. Research to better understand the agro-climatic context.
2. Identification of appropriate cultivars, fertilizers, pesticides, and fungicides adapted to local agro-climatic conditions.
3. Advice to input suppliers, MOA extension agents, NGOs, and farmers regarding appropriate inputs.
4. Training of local input and equipment suppliers in the production of vegetable seedlings, treadle pumps, tube wells, forced-air dryers, and cool storage units/practices.
5. Connecting of input and equipment suppliers to farmers through the promotion of vegetable seedlings, treadle pumps, tube wells, forced-air dryers, and cool storage units/practices.
6. Quality control of technologies introduced.
7. Connecting of input and equipment suppliers and farmers to sources of credit to be invested in production and purchase.

Appendix I; Summary of gaps in peri-urban horticulture support systems and support mechanisms in Liberia

| Horticulture value chain assessment ; Liberia | | | | | | | | | |
|---|---------|--|---|--|---|--|--|---|--|
| | | Input suppliers | Producers | Traders | | Processors | Domestic Retailers | Exports | Consumers |
| | | | | Country traders (middlemen) | Logistics and cold chain providers | | | | |
| SPS and enabling environment | | <p>MINISTRY OF AGRICULTURE No SPS Committee No Pesticide and National Crop Protection Policy No clear guidelines on plant material importations (i.e. there is no national pest list)</p> | | | | | | | |
| | | No Pesticide Law / Regulations No clear plant material importation guidelines No pest listing for Horticultural crops | No information on Good Agricultural Practices No information on registered pesticides | | None available to smallholders | No traceability No quality control systems | No traceability and consumer safety systems No procurement planning | No formal options | No consumers awareness groups |
| Horticultural Production Environment | Issues | Correct seed and plant material No soil testing services Appropriate chemicals/fertilizers Affordable irrigation Affordable crop coverings Poor technical knowledge Access to finance | Cultivars, crop protection, inputs, technical information, on-farm pre-grading, No clear knowledge of Good Agricultural Practices | Ensuring that activity is appropriate and value adding (product bulking, cold chain) | Regular service in cold chain and linkages to final markets | Appropriate raw material standards, seasonality, third party certification, Cold chain | Required third party certification, continuity and quality | Required third party certification, continuity and quality, Government SPS support | Price, continuity of supply, variety |
| | Actions | Determine optimum types and levels of inputs for each crop Develop strong private sector led technical guidelines and support services Assist with business planning to help procure inputs Ensure that practices use integrated pest management from the start | Market linkages, Ensure that appropriate inputs are available, assistance with Good Agricultural Practices, <i>production</i> planning Production guides Irrigation Technical links to markets | Bypassing where appropriate | Necessary assistance in refrigerated transport and/or post harvest loss mitigation strategies | Assistance with Good Manufacturing Practices, <i>production</i> planning, Capital, land (and equity?) for packhouse and cold chain investment. | <i>Procurement</i> planning | Market opportunities based on Liberia's comparative, absolute and seasonal advantages, ensuring more targeted and efficient government SPS and logistical support | Market surveys based on preference and price sensitivity |

Appendix 2; Irrigation

Manual irrigation of vegetables is widely practiced in Liberia during the annual dry season. However, the low capacity of the traditional human energy-powered means used for lifting and distributing water severely restricts the size of irrigated vegetable plots, constraining production and the associated incomes and consumption. Using a bucket or sprinkler can to draw water from a shallow well or surface water source is limited to delivering approximately 1m³/hour, enough to irrigate 200m² to 1,000m², depending on ambient temperatures and soil conditions. Motorized pumps have significantly greater capacity than the traditional manual means, averaging between 5m³/hour and 10m³/hour, but are costly and require expensive petroleum products and spare parts, resulting in high irrigation water costs. High capital and operating costs make such pumps inaccessible to the vast majority of market gardeners in Liberia.

The water table in many lowland areas where dry season vegetable production is practiced is frequently shallow, ranging between less than one foot and several feet. However, during the latter months of the dry season - February, March, and April, the water table drops, significantly reducing the quantity available for irrigation. At that time of the year, shallow hand-dug wells frequently have less than a foot or two of water and insignificant recharge rates. In addition, the sandy sub-surface conditions make it impossible to dig deeper than a few feet where greater quantities of water are to be found.

The FED Project has begun to introduce a high capacity, low-cost human energy-powered irrigation pump called the treadle pump. This technology is capable of lifting and distributing 5m³/hour and the irrigation of 2,000m² to 5,000m². Focusing on current areas of high-value irrigated vegetables, three metal workshops have been trained in Gbarnga and Ganta. As many as fifteen other manufacturing enterprises will be trained in commercially strategic locations over the life of the project. Collaborating with existing input or equipment suppliers and other potential sales people (e.g., farmers who have purchased the treadle pump), vendor networks will be established to expand the outreach of these enterprises. Initially supported by the project, the trained welding workshops will conduct demonstrations and finance the airing of radio spots to publicize the treadle pump technology. These promotional efforts will result in the sale of at least 1,000 pumps benefiting more than 2,000 farmers and their hired/household workers. According to the experience in the West Africa sub-region, these farmers will more than double their incomes from vegetable production.

Limited use of pumps for irrigation purposes in Liberia will require changes in garden layout. The project will assist treadle pump adopters in establishing appropriate irrigation systems adapted to pump-delivered water – use of a plastic or metal drum-reservoir for the reception and redistribution of water in the case of already established gardens or gravity irrigation systems in the case of yet to be established gardens at the beginning of the dry season.

In April, assisted by an expert from Niger, the project will demonstrate and train two local enterprises in the installation of manually installed shallow tube wells. Depending on demand for these wells, between ten and twenty such enterprises will be trained over the life of the project. These technologies – more than one method may be used for installing tube wells (e.g., hand auguring and jetting using the force of pumped water), depending on the sub-surface soil conditions – will increase the availability of irrigation water, sometimes increasing the recharge rates of existing shallow wells and in other cases establishing new wells, making possible higher vegetable yields and irrigated surface areas. Tests conducted in Senegal found that wrapped

slotted or dilled PVC filters inserted into existing wells doubled the recharge rates of those wells, supplying farmers with twice as much water for irrigation purposes. Tube wells will be promoted by the trained enterprises through demonstrations and radio broadcasts.

Appendix 3; Vegetable Drying

Sun-drying of vegetables such as pepper, okra, and bitter ball is widespread in Liberia. Due to humid and rainy conditions, however, drying times are lengthy and losses sometimes significant. Dehydration times appear to vary between one and two weeks, depending on the produce and the time of the year – taking longer during the yearly rainy season than during the dry season. Losses can reach 25 percent. Low productivity and losses during the drying process contribute to the shortage of certain dried products. In the case of dried peppers, this shortfall is filled by imports from neighboring Guinea.

The FED Project will promote the introduction of two forced-air dryers, one heated by propane and another heated by charcoal. Easier to control the temperature, the propane-heated model is expected to develop a strong market in Monrovia, where incomes are higher and where propane is more available and less expensive than elsewhere in Liberia. In Cameroon, 13 kg of red pepper dries in 11 hours using this dryer, generating net revenue of more than US\$35. The charcoal-heated dryer is better adapted to conditions found in Liberia's rural areas, where charcoal is more available and considerably less expensive than propane, and will exhibit lower capital and operating costs.

In June, an expert Cameroonian in the manufacturing and the use of the propane-heated forced-air dryer will train two welding workshops in the manufacture of the dryer. He will also train the project's manufacturer trainer. With the assistance of an American expert, the charcoal-heated version of the dryer will be developed and demonstrated in July. Over the course of the project, five to ten workshops will be trained to produce these dryers. They will generate the sale of an estimated 300 units serving approximately 10,000 users.

Capacity for vegetable drying will be expanded with the introduction of a steam generator. The exhaust created by this generator will be transformed into a force for drying vegetables and many other crops, including rice, cassava, cocoa, and coffee.

Appendix 4; Vegetable Seedling Production

Viable vegetable seedlings are one of the best guarantees for the successful production of certain crops (e.g., cabbage, peppers, collard greens, and onions). However, limited knowledge of seedling production amongst Liberian vegetable growers constrains production of those vegetable crops best grown from seedlings. Commercial seedling producers are also very scarce.

Promotion of seedling production will increase the incomes of both suppliers and producers. One seedling producer in Kakata grows and sells more than 20,000 seedlings a year generating approximately US\$1,000 annually.

The FED Project will conduct a market assessment to include identifying the lessons learned from past and current seedling production programs such as those implemented by Africare and BRAC. If the market study is conclusive, the FED Project will promote the production and sale of vegetable seedlings to be selected on the basis of localized demand and adaptation to agro-climatic conditions. In Year 5, assuming 100 trained seedling producers, average sales of 10,000 apiece, and average purchases per buyer of 200 seedlings, 5,000 farmers will benefit from this intervention.

Appendix 5; Other donor projects

Liberian Agricultural Upgrading, Nutrition and Child Health (LAUNCH)

ACDI/VOCA; LAUNCH is using a value chain approach to help farmers identify market opportunities and address constraints. The program will target commodity value chains such as rice, cocoa, horticulture and poultry. It will also work with private sector businesses and formal financial institutions to implement market-oriented strategies for increasing beneficiary access to products, services and markets.⁹

Bangladesh Rehabilitation Assistance Committee (BRAC)

BRAC is a Bangladesh based organization promotes seedling production and sales as well as commercial vegetable seed production

Liberia, along with Sierra Leone, is one of the newest countries of our international programmes. Established in 2008, we have launched successful programmes in microfinance, health, agriculture, livestock and poultry; reaching more than 582,000 of the poorest Liberians to help them realise their potential. As the programmes expand, we are providing career opportunities for young Liberians eager to contribute to their country's future. We currently employ 161 Liberians (71% women) and have mobilised nearly 300 community-based volunteers as part of our wider team. We invest in their career development through on-going training and capacity-building. Over the next two years, BRAC's microfinance programme in Liberia plans to target and serve more clients, the majority of whom are women members.

BRAC works through the training of 'barefoot' self employed agriculture extension workers who are required to have a minimum of two years agricultural experience and farmed at least two acres of land. They must be willing to work with other low income farmers in their community and supply them with quality inputs. The agriculture extension workers are trained by BRAC program supervisors or extension officers to offer technical assistance to general farmers operating on a small scale, i.e. less than one acre of land.

BRAC agriculture supervisors at the branch level attend microfinance group meetings to identify agriculture extension workers from among the members. The local BRAC branch is responsible for screening and short-listing candidates; the final selection is done by the agriculture extension officers at the area office¹⁰

⁹ [http://www.acdivoca.org/site/Lookup/Liberia-LAUNCH/\\$file/Liberia-LAUNCH.pdf](http://www.acdivoca.org/site/Lookup/Liberia-LAUNCH/$file/Liberia-LAUNCH.pdf), website accessed 03/28/2012

¹⁰ <http://www.brac.net/content/about-brac-liberia>

Appendix 6; Contacts

| Institution | Name and job title | Address | Telephone | E-mail |
|---|---|--|--------------------------|-------------------------------------|
| Ministry of Agriculture, Republic of Liberia, National Quarantine & Environmental Services | Augustus B. G. Fahnbulleh, Director | Libsuco, Old L.P.R.C. Road Somalia Drive, Gardnesville, 1000 Monrovia, Liberia | ██████████ ██████████ | E-mail; ██████████@██████████.li |
| Ministry of Agriculture, Republic of Liberia, | Mai Yuan Director Peri-Urban Agriculture MOA | Libsuco, Old L.P.R.C. Road Somalia Drive, Gardnesville, 1000 Monrovia, Liberia | ██████████ | |
| Ministry of Agriculture, Republic of Liberia | Chea B. Garley, Sr, Assistant Minister for Technical Services | Libsuco, Old L.P.R.C. Road Somalia Drive, Gardnesville, 1000 Monrovia, Liberia | ██████████ | E-mail; ██████████@██████████.li |
| Private Farmer | William A. Tolbert | | ██████████ ██████████ | |

| Institution | Name and job title | Address | Telephone | E-mail |
|---|---|--|--|--|
| LADSI (Land Development Solutions International)-contracted to World Bank to do horticultural review in Liberia | Zongmin Li, Economist, Land Policy and Administration | 992 N. Royal Street, Alexandra, V 22314, USA | +1 (703) 485 6209 | E-mail zli@ladsinc.com |
| Bayer CropScience | Peter Ampofo, Crop Manager, Anglophone West Africa | No address | Tel; +233 302 823 109 Direct +233 302 936 982 Cell; +233 544 341 913 | E-mail; peter.ampofo@bayer.com |
| Greenfield Liberia, | Sam Wazeni | Capitol Bye-Pass, Monrovia, Liberia | Tel; 231 (0) 6 511 331 +231 (0) 6 512 385 +231 (0) 6 524 400 +231 (0) 6 666 600 | E-mail wazni@greenfieldliberia.com sales@greenfieldliberia.com |
| CARE, Liberia | Lynda Garvin, Project Manager | Near Old Road Junction, Tubman Boulevard-Congo Town, Monrovia, Liberia | Tel +231 8807 80261 | E-mail lynda.garvin@co.care.org |
| Wienco Agriculture | Samuel Oduro - Asare, Country Director | Wienco Liberia Limited, P.O. box 1998, 1000 Monrovia 10, Liberia | Tel +231 880 845 440 | E-mail s.asare@wiencoliberia.com |

| Institution | Name and job title | Address | Telephone | E-mail |
|--------------------|--|---|----------------------|--|
| Wienco Agriculture | Dominic Fuachie - Sobreh Technical Manager/Agronomist | Wienco Liberia Limited, P.O. box 1998, 1000 Monrovia 10, Liberia | Tel +231 880 807 654 | E-mail d.sobreh@wiencoliberia.com |
| Welthungerhilfe | Andre Steider, Head of Project | Deutsche Welthungerhilfe e.V., 18th Street, Sinkor, Monrovia, Liberia | Cell +231 6 133 295 | E-mail andre.steider@welthungerhilfe.de |