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Scoping Study

Vegetable Value Chains in the Dry Zone and Ayeyarwady Delta of Myanmar: A Scoping Study of Smallholder Farmers' and Traders' Needs

November 2017

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The World Vegetable Center is an international nonprofit institute committed to alleviating poverty and malnutrition by realizing the potential of vegetables for healthier lives and more resilient livelihoods. WorldVeg's improved varieties, production and postharvest methods help farmers increase vegetable harvests, raise incomes in poor rural and urban households, create jobs, and provide healthier, more nutritious diets for families and communities.

Research in Action

The *Research in Action* series disseminates the practical application of the Center's work in vegetable breeding, production, marketing, and nutrition. The series aims to encourage vegetable-based enterprise through the extension of ideas, technologies, and skills.

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Trader in Pyapon Market, Ayeyarwady Delta

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Contents

Executive Summary	5
Constraints and Recommendations	6
Introduction	7
Objectives and Targets of the Study	9
Methods and Data	9
Major Findings	17
Conclusions	34
Recommendations	36
References	42
Acknowledgements	44
Appendices	44
<i>Appendix 1. Semi-Structured Interviews of Vegetable Traders and Retailers</i>	45
<i>Appendix 2. Farmer and Farm Visits: unstructured interviews and direct observations</i>	51
<i>Appendix 3: Vegetables sold in the markets and those grown on farms or in household gardens</i>	59

Executive Summary

A scoping study was conducted in Magway, Dry Zone and Ayeyarwady Delta region of Myanmar to determine the needs of smallholder farmers and traders relating to vegetable production, postharvest handling and consumption.

A total of 151 farmers from six townships in Magway and Ayeyarwady were engaged in focus group discussions and semi-structured interviews, and results were combined with direct observation of fields and markets to make assessments and recommendations. Semi-structured interviews were also conducted with six vegetable traders across both regions to gain preliminary information on marketing aspects. Locations in Ayeyarwady were chosen to enable a comparison between villages strongly affected by salinity with less- and non-affected ones.

The results show that farmers in the Dry Zone and Ayeyarwady Delta regions face a wide range of constraints when growing vegetables (a list of all vegetable crops observed in gardens/farms and markets can be found in Appendix 3). Salinity is a serious constraint to vegetable production in the lower parts of the Delta and during the latter phase of the dry season growing vegetables becomes extremely difficult. Infertile red clay soil hinders vegetable production in parts of the Dry Zone and water availability is a major constraint where wells are not present.

Heat is a major constraint to tomato production in the Dry Zone and yields drop dramatically during the hot-dry season (March-May). Commercial tomato farmers there are strongly requesting heat-tolerant tomato varieties, since they can fetch high prices during that season.

Pests and diseases reduce yields on many vegetable crops in the Dry Zone and the Ayeyarwady Delta; farmers therefore need integrated pest management (IPM) solutions and training on how to implement them, especially on tomato, amaranth, yard-long bean, chili pepper, eggplant, cucurbits, radish and other crucifers.

Farmers have numerous constraints with selling vegetables, among them fluctuating market prices, limited marketing channels since transportation from their villages to the townships is inconvenient, and collectors/retailers manipulating the amount of produce they want to buy based on quality. In some cases they only pay the farmers 10-15 days later. Training activities on postharvest handling are therefore very likely to benefit farmers and enable more stable marketing linkages.

Major constraints and recommendations include:

<i>Constraint</i>	<i>Recommendation</i>
Tomato production drops dramatically in the hot season	Introduce WorldVeg's heat-tolerant tomato lines to growers, seed companies, NGOs and the Myanmar government
Off-season tomato production faces many biotic and abiotic constraints, and these hinder growers from taking advantage of high prices	Introduce WorldVeg's off-season tomato production package, which includes heat-tolerant and disease-resistant lines, low-cost rain shelters, fruit-setting hormone, grafting, and raised beds with deep drainage systems to growers, Myanmar government organizations and NGOs
Viruses, bacterial wilt and other diseases greatly reduce vegetable production	Introduce WorldVeg's disease-resistant, high-yielding and other improved vegetable lines, especially bitter melon, pepper and tomato, as these are important crops for Myanmar farmers with many production constraints
Infertile soils decrease production	Implement soil nutrient enrichment through composting with locally-available materials
Low water availability limits vegetable production	Introduce and promote drought-tolerant vegetable crops including WorldVeg improved lines and water harvesting techniques, especially in the Dry Zone
Production is limited by seedling care and seed saving techniques	Train farmers, youth with entrepreneurial interests, and nursery operators on healthy seedling production technologies and how to save and store seeds
Use of post-harvest handling techniques is minimal	Build capacity among traders and farmers on post-harvest handling technologies; establish vegetable collection points in villages to enhance post-harvest handling
Salinity reduces vegetable production in the dry season and flooding does in the wet season in the Ayeyarwady Delta	Introduce and promote saline-tolerant and flood-tolerant vegetable crops, including WorldVeg improved lines, in the Delta
Waterlogging and apparently soil-borne diseases limit	Graft tomatoes, eggplants, peppers and cucurbits to overcome constraints due to soil-borne diseases,

<i>Constraint</i>	<i>Recommendation</i>
vegetable production	waterlogging and minor flooding, after identifying disease constraints more specifically
Rain, waterlogging and flooding constrain wet season vegetable production	Train farmers on how to produce more vegetables in the wet season, including flood-tolerant species, rain shelters and other protected cultivation technologies, drainage systems and more
Flea beetle, aphids, whiteflies, red pumpkin beetle, armyworm, legume pod borer, fruit flies and other insect pests reduce vegetable production	Introduce integrated pest management (IPM) solutions for a wide range of pest problems; develop capacity of farmers and extensionists to implement these effectively
Poor quality vegetable seeds in markets	Explore different approaches to increase the quality of seed supplies, such as improving private sector seed systems and developing community seed banks
Seeds sold in markets are often counterfeit, meaning that people have refilled seed packets from reputable companies with low quality seeds and sold them	Establish and enforce laws that prohibit packaging and selling counterfeit seeds

Introduction

Rice has long been the primary crop grown in Myanmar due to its role as a staple food crop and corresponding national policy. However, because of its high production costs and externally controlled price, farmers have difficulty making a profit from rice production. To increase the profitability and sustainability of irrigated land, it is necessary to diversify land use to incorporate high-value crops such as vegetables, and promote their production in rotation with rice. Many farmers in these areas do not know how to grow crops other than rice because only rice has been grown in most irrigated areas to this point. Farmers also have difficulties accessing extension systems to increase their knowledge to diversify their crop production (JICA Final Report 2013; LIFT Baseline Survey Report 2012).

However, there are still additional constraints for farmers to grow vegetables besides the limitations of farmers' knowledge. Extreme climatic events such as dry spells and flooding dramatically reduce crop production in Myanmar. In the Dry Zone, "dry spells" (defined as short periods without rainfall) are normal during the monsoon. Dry spells usually occur around July, during the early part of the monsoon. However, if they last for prolonged periods (i.e., more than 2 to 3 weeks), this can cause problems for farmers. Early retreat of the monsoon also constrains farmers' crop production in the Dry Zone. Although the end of the monsoon is generally more predictable than the onset, it sometimes ends earlier than expected, leaving crops without water before they are ready for harvesting (IWMI 2013).

The powerful tropical cyclones such as Cyclone Nargis in 2008, Cyclone Giri in 2010 and Cyclone Komen in 2015 seriously struck Myanmar and diminished its agricultural production. Cyclone Komen destroyed 80 percent of the cultivated flooded area in Ayeyarwady, followed by Magway with 52 percent and Sagaing with 34 percent, resulting in total loss of production in affected areas (FAO 2015).

Availability of quality seeds of many crops has been erratic due to unregulated imports of low quality seeds and lack of seed distributors and other supply mechanisms to meet the demands of individual farmers. A national system to disseminate quality approved seeds has not been well established due to shortage of human resources for extension activities to provide instruction on quality control of seeds. Although the Seed Act has been in force since 2012 with the assistance of FAO, its executive regulations have not yet been established and seed policy has not yet been formulated. In addition, supply of farm inputs such as fertilizers and other agricultural chemicals is not enough to meet demand (JICA Final Report 2013).

Lack of ownership of sufficient land has also been an obstacle for Myanmar farmers. Land ownership is not universal and highly inequitable in its distribution among the rural population. There are also large differences in the size of land holdings. The very skewed distribution of land ownership in the Delta/ Coastal Zone raises concerns of equity when providing agricultural assistance in these areas. Landless participants reported that the opportunity for them to gain access to land for cultivation is very limited (JICA Final Report 2013; LIFT Baseline Survey Report 2012).

Smallholder farmers lack access to price information. Nearly a quarter of households marketing their produce had no price information before selling it. Smallholder farmers usually cannot store their produce for two or more months after harvest. Slow progress for streamlining post-harvest treatment facilities has led to high rates of loss of perishable vegetables before marketing. On the other hand, larger and wealthier agricultural producers are more likely to know the price of their main crops before selling them and they are more likely to store and sell their crops some months after the main harvest season (JICA Final Report 2013; LIFT Baseline Survey Report 2012).

Objectives and Targets of the Study

Magway Division in the Dry Zone and Ayeyarwady Division in the Delta were targeted in this scoping study.

The Ayeyarwady region has been heavily hit by cyclones during the past ten years. Serious floods caused by cyclones usually have a significant impact on crop production. This increases the risk for food insecurity and malnutrition in this region (JICA Final Report 2013; FAO 2015).

Agriculture in the Dry Zone is heavily dependent on the southwest monsoon but low annual precipitation with an irregular and unpredictable distribution over time and space causes both water shortages and localised flooding. The soils are clay- and sand-rich and have a high risk of erosion from water and wind, leading to land degradation. This poses a regular threat to rural, agriculturally-dominated livelihoods, causing localized crop failures and losses. Consequently, the Dry Zone is one of the most food insecure areas in the country. The situation is characterized by a reliance on market purchases for food access in a context of low, undiversified, agriculture-based incomes, high debts, and reliance on credit (WFP 2013).

The aim of this study was to assess constraints and opportunities to increased vegetable production and consumption in Chauk, Yenanchaung and Seikphyu Townships of Magway Division, and Pyapon, Bogale and Mawlamyinegyun Townships of Ayeyarwady Division. Post-harvest and marketing aspects are also included.

Methods and Data

This scoping study was conducted among 151 farmers from six townships in the Magway and Ayeyarwady Divisions (Table 1). Figure 1 shows the locations of the focal townships: Chauk, Yenanchaung and Seikphyu in Magway Division; and Pyapon, Bogale and Mawlamyinegyun in Ayeyarwady Division. World Vision Myanmar (WVM) selected the study areas where there is potential to support farmers and household gardeners to improve their vegetable farming based on limited successful efforts to date but a wide range of substantial constraints remain; in most of these locations WVM has ongoing agricultural activities. Several participatory appraisal methods were used to collect data.



Figure 1. Six townships (red stars) in the scoping study.

Focus group discussions, semi-structured interviews, and direct observation of fields and markets were used to briefly assess biotic and abiotic constraints to vegetable production, post-harvest handling issues, marketing concerns, consumption issues and other related topics in the target regions. The locations of these activities and the dates they were conducted are in Table 2.

Data collected in Mawlamyinegyun Township were used to compare with data collected in Bogale and Pyapon Townships to assess how salinity influences vegetable farming.



Figure 2. Focus group discussion about vegetable production, post-harvest handling, marketing and consumption with farmers in Yenanchaung Township.

Table 1. Study structure and numbers of respondents.

Item	Magway Division	Ayeyarwady Division	Total
Townships	Chauk Township; Yenanchaung Township; Seikphyu Township	Pyapon Township; Bogale Township; Mawlamyinegyun Township	6 townships
No. of individual farmers interviewed	8	6	14
No. of market visits and vegetable sellers	2 market visits and 2 vegetable sellers interviewed	2 market visits and 4 vegetable sellers interviewed	4 market visits and 6 vegetable sellers interviewed
No. of general discussions conducted and farmers	2 general discussions with approx. 35 farmers	1 general discussion with 2 farmers	3 general discussions with approx. 37 farmers
No. of focus group discussions conducted	3	4	7
<i>General characteristics of focus groups</i>			
AGE			
<i>20-30 (or below 20)</i>	3 (8%)	11 (19%)	14 (15%)
<i>31-40</i>	11 (31%)	30 (34%)	31 (33%)
<i>41-50</i>	10 (28%)	8 (14%)	18 (19%)
<i>51-60</i>	8 (22%)	11 (19%)	19 (20%)
<i>above 60</i>	4 (11%)	8 (14%)	12 (13%)
SEX			
<i>Male</i>	20 (56%)	33(57%)	53 (56%)
<i>Female</i>	16 (44%)	25 (43%)	41 (44%)

Table 2. Locations of main scoping study activities and dates conducted (2017).

Village	Township and Division	Focus Group Discussions	Market interviews	Individual farmer interviews (unstructured) and direct observations of their home gardens or fields
	Seikphyu, Magway*	13 Feb		
Nayweltow	Chauk, Magway	14 Feb		14 Feb
Others	Chauk, Magway		13 Feb	13 & 14 Feb
Ywar Thit Gyi	Yenanchaung, Magway	15 Feb		15 Feb
Others	Yenanchaung, Magway		15 Feb	15 Feb
Shan Kwin Gyi	Pyapon, Ayeyarwady	17 Feb		17 Feb
Achar Kalay	Pyapon, Ayeyarwady	18 Feb		18 Feb
Others	Pyapon, Ayeyarwady		17 Feb	
Kun Thee Chung	Bogale, Ayeyarwady	19 Feb		
Others	Bogale, Ayeyarwady		20 Feb	19 Feb
Mazeli Tel Kone	Mawlamyinegyun, Ayeyarwady	20 Feb		20 Feb

* This FGD was held in the Chauk WVM office.

Focus Group Discussions (FGDs)

World Vision Myanmar invited vegetable farmers and household gardeners in the aforementioned townships to participate in the FGDs. For each FGD, through simple random sampling, we sought to recruit farmers/gardeners from 15 households with a mixture of: (1) men and women; (2) commercial farmers and small scale gardeners. Those selected fit some combination of the following criteria: (1) members of farmer groups formed with the support of WVM; (2) individual small scale vegetable growers; (3) small scale home gardeners; (4) commercial producers; (5) vegetable growers who used irrigation water from small reservoirs developed with the support of WVM.

Each FGD was conducted by a study team composed of a local trained moderator, Myanmar agricultural specialist/translator, innovation systems specialist and program officer.

For FGDs, one interview topic guide was developed and translated into Burmese for use at all sites. Questions for the Focus Group Discussions were open-ended and started with an engagement question as an “ice-breaker”, followed by exploration questions to gain key information, and finishing with an exit question (Eliot & Associates 2005):

- Engagement question:
 - What is your favorite vegetable and why?
- Exploration questions:
 - What vegetables do you grow on your farm or home garden?
 - What problems or constraints do you have when growing vegetables?
 - Explore in more detail issues with seeds, pests/diseases, soil quality, water availability, etc.
 - Which vegetables are easiest to grow and produce well?
 - After you harvest the vegetables, what do you do with them?
 - Of the vegetables you harvest, what proportion do you consume and what proportion do you sell?
 - How often do you and your family eat vegetables?
 - Which ones do you most commonly eat?
 - What problems or constraints do you have with selling vegetables?
 - What are the different roles of men and women in vegetable production?
- Exit question:
 - Is there anything else you would like to add about vegetables?
 - To probe for further information, bring up the topics of seeds/planting material, cultivation, harvesting, post-harvest handling, marketing and consumption

Data collected from FGDs were transcribed, analyzed and triangulated by multiple researchers.

Market interviews

Local World Vision staff in each township brought the team to major vegetable markets in Chauk, Yenanchaung, Pyapon and Bogale to interview vegetable traders. We selected traders who were selling a relatively wide range of different vegetables and who were willing to answer questions. A market interview topic guide developed by WorldVeg¹ was used for market visits at each site.



Figure 3. Scoping study team interviewing trader in Pyapon Market.

Direct observations

During the farmer visits in particular, but at all times during the study, the team made qualitative observations about biotic and abiotic constraints, agroecological factors, socioeconomic aspects, and any other factors deemed relevant to this study. Photographs were taken.

¹ The market interview topic guide was developed by WorldVeg for its participatory appraisal of stakeholders' needs conducted in Bali and East Java in the USAID-supported "Vegetables for Indonesia" project (2011-2015).



Figure 4. Vegetable field and home of a Chauk farmer the team interviewed.

Individual farmer and gardener interviews

Local World Vision staff in each township introduced the team to individual farmers and household gardeners, whom we interviewed in an unstructured and informal fashion in their vegetable fields, to adapt to each situation. Therefore, the farmers were able to show us directly the production and other issues raised. These farmers were representative of other farmers/gardeners in their village.



Figure 5. Household gardener in Bogale the team interviewed.

Major Findings

Focus Group Discussions (FGDs)

Since the Dry Zone and Ayeyarwady Delta are distinctly different agroecological regions, the major findings for each are summarized separately first and then overall findings are discussed. The major agroecological feature of the Dry Zone is the lack of water availability much of the year, whereas the Ayeyarwady Delta has an overabundance of water during the wet season and salinity problems near the ocean in the dry season. Table 2 provides the names of villages and townships where the FGDs were held.

Magway, Dry Zone

Seikphyu Township is on the opposite side of the Ayeyarwady River from Chauk and Yenanchaung Townships. Seikphyu receives substantial amounts of new soil annually from the river and has sufficient water access, which enables most of its farmers to be commercial producers. However, this is not the case in Chauk and Yenanchaung. The farmers and household gardeners selected for the FGDs were representative of their townships, therefore, the Seikphyu group was very commercially oriented whereas the Chauk and Yenanchaung groups were more even mixtures of commercial farmers and home gardeners.

The engagement question, *What is your favorite vegetable and why?*, could be interpreted in a number of ways – what the participants like to eat, grow or prefer in another respect – however, most responded in terms of what they like to consume. Bottle gourd fruits and shoots, water spinach (kangkong), pumpkin, tomato, roselle and amaranth were the most frequent responses. Reasons included affordability, nutrition, reduction of toxicity, and that these had been eaten for generations.

To *What vegetables do you grow on your farm or home garden?*, participants most commonly listed bottle gourd, tomato, radish, chili, roselle, pumpkin, eggplant, yardlong bean, coriander, water spinach, bitter gourd, and ridged gourd.

The most commonly noted problems or constraints to growing vegetables were limited water supply, limited access to quality seeds, and lack of knowledge on vegetable production, especially field management and pest/disease control. False or counterfeit seeds are often sold and these undermine farmers' productivity. Commercial vegetable farmers from Seikphyu specifically mentioned disease problems on tomato, onion and chili pepper; possible reasons they noted were continuous cropping and degraded soil fertility. They apply cow dung, organic fertilizer and green manures to address this. They also highlighted their lack of knowledge on pesticides (type and dosage) and insufficient understanding of different development stages of insects. They expressed their need for further education on how to produce safe vegetables. Farmers in Yenanchaung said they lacked knowledge on vegetable production technologies such as seedling

preparation, soil conservation, how to save seeds, and how to deal with fluctuating market prices, especially in onion.

When asked, *Which vegetables are easiest to grow and produce well?*, bottle gourd, pumpkin, roselle, radish, and water spinach were most frequently mentioned.

To the question *After you harvest the vegetables, what do you do with them?*, the respondents answered that part are consumed by their families while the rest are sold. In general, during the hot season, farmers plant less and the produce is only for family consumption. During the wet season, farmers plant more for their own consumption and for sale. Some vegetables are sold in their own village, some are transported to the township by public transportation for sale, and in some cases retailers come to the farms to buy directly from farmers. Commercial farmers in Seikphyu said they store onion for many days to wait for higher market prices; tomato can only be stored for a few days, but sun-dried chili can be stored longer.

Regarding the proportions of the harvest that are consumed versus sold, Chauk farmers/gardeners noted that they consume 25-50% and sell 50-75%. Likewise, Yenanchaung farmers/gardeners consume 70% and sell 30%. The more commercially-oriented Seikphyu farmers only eat 1-10% of their harvest and sell over 90% of it. They sell 99% of the tomato they produce over four growing seasons annually. For onion and chili, they consume 10% and sell 90%; onion is only grown once a year. They plant small amounts of bottle gourd and pumpkin for family consumption only.



Figure 6. Seikphyu farmers who participated in the Focus Group Discussion.

To *How often do you and your family eat vegetables?*, farmers/gardeners responded that they eat them 2-3 times a day. Bottle gourd (fruits and shoots), tomato, and chili are the most commonly consumed vegetables.

Problems and constraints with selling vegetables are numerous. Commercial farmers in Seikphyu complained about fluctuating market prices for tomato and that farmers suffer from low prices when there is too much supply in the markets. When prices are too low then it is not economical to transport it to the township for sale. For chili, farmers can store the dried produce and sell when the price is good. In Chauk, farmers sell vegetables in their village because transportation to the township is not convenient; however, buyers only pay them 10-15 days later. In Yenanchaung, retailers often come to the farm to collect the produce, however, retailers ask farmers to remove the damaged vegetables and refuse to buy if such problems continue. Therefore, training on postharvest handling would be a useful intervention to help farmers.

Regarding gender roles, overall the participants said that men and women each cover 50% of the farm work (production process), however, men usually handle the heavy types of work such as land/bed preparation and bamboo staking, while women handle planting, tying plants to stakes and work that needs more care. In Chauk, they said the women's types of work requires much more time than the men's work. In Yenanchaung, women handle more work than men because most men work in other villages, townships or even other countries such as Malaysia. Seikphyu farmers noted that, while normally the farm work is divided 50-50, if men lose their wives they hire laborers to cover the 50% normally done by women; however, if women lose their husbands they will handle 100% of the work.

The exit question, *Is there anything else you would like to add about vegetables?*, elicited a range of responses. Commercial farmers from Seikphyu said that unreliable market prices are the biggest constraint they face. They want to try off-season tomato production (off-season: March-May is the hot-dry season, June-October is the hot-wet season), however, they do not have access to tomato varieties that fit off-season conditions. The best season for growing tomato is the cool season (October to December/January); if they grow during March-May there are no flowers or fruits. Normally they grow tomato June to December. However, in June to October, they experience some heavy rain, but they still get some produce. In Oct-Dec, the yield is twice that of Jun-Oct. During the wet season, disease levels are higher, so they use more fungicides. They said they cannot take the risk to try to grow something different or new unless somebody tries it first to show it can be successful. There is no farmer group available in the village – farmers have to rely on themselves to learn vegetable production technologies. WVM is just starting to facilitate group formation here.

Farmers/gardeners in Chauk and Yenanchaung expressed their need for knowledge of all kinds of vegetable production technologies, good quality seeds, and market information and knowledge. Some complained that other villagers nearby transport

their produce to other places and get higher prices, but do not share the marketing channels with them. When transporting their produce to distant townships, farmers pack it in bamboo baskets; for selling in their own village, farmers use plastic bags for packaging.



Figure 7. Focus Group Discussion in Bogale, Ayeyarwady Delta.

Ayeyarwady Delta

As their favorite vegetable, participants mentioned roselle, water spinach, okra, amaranth, yard-long bean, bitter gourd, bottle gourd (fruits and shoots), chili, eggplant and radish most frequently. Reasons why included that they are good for one's health, have been grown for generations, are adapted to the environment, and are easily accessed in the market. In the case of radish in Mazeli Tel Kone village, Mawlamyinegyun Township, it is the main source of income for the village.

Vegetables most commonly grown on the participants' farm or home garden include radish, roselle, okra, water spinach, bottle gourd, cucumber, bitter gourd, yard-long bean, snake gourd, amaranth and chili.

What problems or constraints do you have when growing vegetables? elicited a wide range of responses. Salinity is a major constraint in Kun Thee Chung village, Bogale Township and Achar Kalay village, Pyapon Township. In Kun Thee Chung a canal can provide fresh water from the rainy season up through February (partway through the dry season), but in the latter part of the dry season the canal water becomes saline and is not suitable for irrigating vegetables. Water from tubewells can be used to grow vegetables during this difficult period, but the village does not have enough tubewells to satisfy demand.

In Achar Kalay, fresh water is available throughout the wet season, however, in the dry season fresh water can only be drawn from the river for three days out of every two weeks, due to the tide cycle. Farmers/gardeners noted that salty water reduces the size of roselle plants and with stronger salinity all vegetable crops will be killed.

Land availability is another constraint in many areas, especially during the wet season when most land is flooded for growing rice. Limited knowledge on how to grow vegetables was mentioned, in particular regarding cabbage, cauliflower, carrot and tomato.

Pest and disease constraints are numerous, and usually arise when the planting time is late and temperatures increase. Farmers apply pesticides about once a week. Vegetables are affected mostly by aphids, legume pod borer and cutworms. Almost all kinds of vegetables have pest problems. When problems occur, the farmers seek advice from pesticide suppliers.

Yardlong bean, cucumber, okra, chili, and radish were specifically mentioned as having pest/disease problems. The main ways farmers control pests include: manually collecting and destroying, and application of hand soap, chemical or natural pesticides. The natural pesticides include tobacco leaves mixed with garlic and ginger in water. Farmers in Kun Thee Chung said this combination is the best to control pests. The worst pests are black, pink and orange beetles.

Chili has problems with anthracnose and the leaves curling and rotting back. Farmers in Mazeli Tel Kone have problems with flea beetles, caterpillars and fruit flies. Stem flies on tomato and fungus on radish are constraints. Flea beetles are their most difficult constraint, causing reduced quality of the radish. They cannot control it and they want to know about control methods. Netting does not work. Farmers use fungicides, carbofuran, and foliar pesticides.

In general, farmers think that soil fertility is degrading annually and topsoil is becoming thinner due to continuous rice farming and application of chemical fertilizer. Animal manure and compost are used to alleviate the problem. Compost is made from rice straw, chicken manure, pig waste and cow dung.

Seed quality is another significant constraint. Farmers/gardeners in Pyapon Township complained that germination rates of roselle and water spinach are low. Some farmers are interested in learning how to save their own seeds because seeds from markets do not always have good germination rates.

In response to the question, *Which vegetables are easiest to grow and produce well?*, farmers/gardeners named radish, roselle, cucumber, okra, yard-long bean, bottle gourd and water spinach (kangkong).

When asked, *After you harvest the vegetables, what do you do with them?*, participants from all FGDs except one said they sell their vegetables in their own

village or at nearby markets. The Mazeli Tel Kone group noted that there are ten middlemen in the village, so they can sell by their home, where the middlemen collect. The middlemen then sell to Bogale, Mawlamyinegyun and Pyapon townships. They transport vegetables at night – usually at 2-3am they start selling and finish by 10am. The transportation and selling are mainly done by men. Before they return home, they telephone information to their wives, who then start to collect.

No postharvest handling is done in most cases. Minimal measures are taken in some cases such as putting water on the produce, covering it with a wet cloth or banana leaves, or packing it in bamboo baskets.

FGD participants in both villages of Pyapon District and in Kun Thee Chung, Bogale said that their family consumes 20-30% and they sell 70-80% of the vegetables that they harvest. In Mazeli Tel Kone they are more commercially-oriented – they only consume 5% while selling 95%.

Two groups noted that they eat vegetables at “every meal”, another does twice a day, while another responded “everyday and three times a day”. Water spinach, roselle, okra, eggplant, radish and bottle gourd shoots are most commonly consumed. It is very popular to eat vegetables with fish paste.

The question, *What problems or constraints do you have with selling vegetables?*, elicited various responses. The two villages with salinity problems – Achar Kalay, Pyapon and Kun Thee Chung, Bogale – only produce small amounts of vegetables which are sold mainly within their own villages. In contrast, the other two villages are more commercially-minded and they encounter problems with oversupply in the markets and low prices, so sometimes they throw away their produce. This happens most often with radish and roselle, but this can occur with all kinds of vegetables.

Farmers and household gardeners would like to learn how to grow vegetables during the wet season. In Kun Thee Chung village, introducing flood-tolerant vegetables would help them increase production during the wet season.

All four villages reported similar roles for men and women in vegetable production. Men carry out land and seedbed preparation, plowing and watering. Women sow seeds, water, weed, harvest, mulch with rice straw, sell the produce and interact with retailers.

To the final question, *Is there anything else you would like to add about vegetables?*, farmers/gardeners had many requests. They have found Effective Microorganisms (EM) bokashi to be very good but they lack key ingredients – EM solution and sugary liquid – to make it. They need technologies for seed production and selection, cultivation, pest and disease management, soil fertility and postharvest handling. Farmers want to learn control methods specifically for fungi,

soil conservation methods, more market information, and where to buy lemongrass oil for pest management.

Achar Kalay farmers are interested in obtaining *hingela* (spider plant), star bean, mungbean, black gram, and flood tolerant tomato seeds for their village. Shan Kwin Gyi farmers need good open-pollinated varieties of tomato, eggplant, yard-long bean and bitter gourd to produce good products and propagate good quality seeds themselves.

Summary and Analysis of Focus Group Discussions

Farmers and household gardeners often have problems with obtaining good quality vegetable seeds from the markets. The seeds often have low viability or are counterfeit, meaning that people have taken seed packets from reputable companies and refilled them with low quality seeds, and then sold them to farmers. This practice undermines farmers, seed companies and project staff. Although some farmers have saved seeds of some vegetables, they are not aware of the proper storage methods for keeping the seeds at good quality levels before the next cropping. Farmers and gardeners most commonly store vegetable seeds in bottles and plastic bags; however, they also keep them in metal boxes, envelopes and still in their pods hanging from the roof. Conducting **training on seed saving and conservation** can enhance farmers' knowledge on how to successfully save vegetable seeds and conserve them. A training course with hands-on practices on selected vegetable crops can be very helpful and useful for farmers. To ensure continuous and reliable seed supplies within villages, **community seed banks** can be established. **Reliable private seed sector institutions** can be linked to village retailers to extend their services to remote villages. This will require the local government's policy support for smooth implementation. Most farmers are willing to accept hybrid vegetable varieties if their performance is good, so marketing potential for seed companies is increasing.

Pest and disease problems are one of the major constraints that farmers face with vegetable production. Farmers often plant the same crop on the same land continuously and this causes disease problems and degrades soil fertility. Farmers' annual planting calendars need to be reviewed and suitable **crop rotation** plans should be recommended for them as the first step for managing pests and diseases. Farmers have limited information on pest and disease management and are not aware of many integrated pest management methods. Farmer groups are apparently not common or not available in most villages, and therefore farmers have limited channels to obtain necessary knowledge and information on pest and disease control. We recommend conducting **training on integrated pest management (IPM)** and forming **farmers' groups**. These groups can be used as channels for continuously providing updated IPM information for use in home gardens as well as in commercial fields.

Compost can be highly beneficial for improving soil fertility and plant health. Routinely applying compost can optimize potential yields and quality. Farm residues/wastes such as rice straw, grass, crop residues, leaves, animal manures, wood ash, kitchen scraps and other locally available materials are recommended to make the compost. This can be done through demonstration and hands-on practices to enhance farmers' knowledge on compost production and application. Strictly implementing **crop rotation** with green manure can improve soil fertility. To sustain such practices, linking with local research institutes or extension offices to establish **balanced fertilization and soil conservation guidelines** can be helpful. Limited water supply is a serious issue during the hot-dry season, especially in the Dry Zone. Farmers/gardeners usually must reduce their area planted to vegetables. However, simple **mulching** can prevent loss of soil moisture and moderate soil temperature. This can be done by placing locally available materials such as rice straw or banana/coconut leaves on the soil surface. In addition, **drip irrigation** and **rainwater harvesting** can also be implemented when applicable. Locally common vegetables such as roselle, amaranth and spider plant (*hingala*) are **drought tolerant** and we recommend promoting them in the Dry Zone to be planted during the hot-dry season.

Postharvest handling/treatment is not commonly implemented by farmers or traders to maintain produce quality after harvesting. Retailers often come to the farm to collect the produce, however, retailers ask farmers to remove the damaged vegetables, and refuse to buy if such problems happen again. To avoid farmers being manipulated by the retailers/collectors, **postharvest training** is needed. Properly sorting, grading and protection packaging can help farmers obtain better profits and reduce the losses due to transportation damage. We recommend promoting **key postharvest concepts** to potential entrepreneurs who can introduce postharvest technologies to interested stakeholders and link to markets. Training for farmers on **easy-to-apply techniques/methods** for handling their produce properly is also recommended, along with guidance on how to aggregate their efforts to supply these entrepreneurs. **Vegetable collecting points** can play a major role in postharvest handling and this needs long-term investment from local farmers' groups and the government.

Oversupply of certain vegetables such as onion, chili and tomato often results in low market prices, so that sometimes it is not worth it for farmers to harvest the produce, especially for tomato. Farmers can store onion and dried chili for certain periods and sell them when the price is higher. However, tomato can only be stored for a few days. Farmers want to try **off-season tomato production** because the price is very high in the market; however, they lack knowledge on off-season production technologies. WorldVeg has developed an off-season tomato production technology package which includes heat-tolerant tomato varieties, raised beds, rain shelters, fruit-setting hormone and integrated crop, pest and disease management. Tomato grafting can overcome soil-borne diseases and waterlogging or minor flooding. In the hot-wet season, **long-shelf life tomato varieties** can help farmers maintain produce quality. Vegetable collecting points can be set up for controlling

the market supply, establishing transparent market demand and implementing cooperative marketing.

Pyapon and Bogale Townships are close to the ocean and salinity in river/canal water is the primary constraint for farmers there in the dry season, when they have limited or no fresh water to irrigate their vegetables and therefore the production is very restricted. In Achar Kalay village, farmers can get fresh water for irrigation once every two weeks; **vegetable production in bags** is one alternative for growing vegetables from February to May, for home garden use. Planting saline-tolerant vegetables is another option. However, none of the locally common vegetables are saline tolerant. It is difficult to successfully introduce new/different crops unless demonstrations are provided.

In general, farmers/gardeners in both the Dry Zone and Ayeyarwady Delta often lack knowledge in vegetable production technologies, such as seedling preparation, drip irrigation, fertilization and pest management. Conducting **production technology training** for selected vegetables can be a quick way to enhance farmers' knowledge on certain vegetables. However, to continuously provide the updated production information and advice on vegetable production for farmers, **strengthening local agricultural extension** functions could be the key.

Market interviews

Six traders were interviewed -- two in the Dry Zone (one each in Chauk and Yenanchaung) and four in the Delta (two each in Pyapon and Bogale).

All of them stated that product quality is a concern and five of them gave specific examples of how much they mark down their prices if they are selling low quality vegetable produce. However, none of them take any postharvest handling measures to ensure good product quality. The strategies mentioned to ensure quality are to only collect high quality produce and try to sell quickly. In most cases the traders said they are able to sell everything within a day, but if the produce degrades, they throw it away.

Vegetable prices have fluctuated dramatically over the past three years; the trader in Chauk Market said her tomato prices have ranged from 100 to 2,000 Kyats/1.6kg during that period. In Yenanchaung Market the trader has sold the smallest chili variety for 2,000 to 12,000 Kyats/1.6kg over the past three years. In Pyapon Market, the seller said her tomato prices have ranged from 600 to 2,500 Kyats/1.6kg in the same period. Additional data can be found in Appendix 1, which contains the questions and responses from all market interviews.

When asked, *Where do you buy and sell these vegetables?*, the traders had a wide variety of responses. Many in the Delta source their produce from Yangon Market, and three of them travel there themselves to buy directly. The Chauk Market trader

said farmers bring all the produce to her there to sell. Traders noted that they mark up their prices around 15-40% from the farm gate price or wholesaler's price.



Figure 8. Trader in Chauk market the team interviewed.

Direct observations

An interesting comparison between saline and non-saline environments is provided by Kun Thee Chung village versus Mazeli Tel Kone village. The latter is essentially just upriver from the former. The level of prosperity is substantially lower in saline-embattled Kun Thee Chung than it is in Mazeli Tel Kone, based on the quality of housing. Of course, other factors may also play a role in explaining these differences, but salinity appears to be a major causative factor.



Figure 9. Houses in Kun Thee Chung village, Bogale, where salinity is a major constraint.



Figure 10. Houses in Mawlamyinegyun (near Bogale), where salinity is not a constraint.

Farmers in Chauk Township have problems with red clay soil that is infertile, hard, sticky, and difficult to work with (Figure 11). Recommendations for addressing this are noted below.



Figure 11. Red clay soil in Chauk Township, Magway, Dry Zone, that hinders production of many vegetable crops.

Home gardens in Chauk are only productive during the rainy season due to water shortages the remainder of the year (Figure 12). We therefore recommend that drought-tolerant vegetables be promoted or introduced to extend production into the dry season as much as possible. More details are noted in the Recommendations section below.



Figure 12: Limited water sources in the Dry Zone – an artificial pond supported by a WVM project in Chauk Township is used to irrigate a vegetable demonstration plot.

Tomato farmers in Yenanchaung Township are requesting heat-tolerant varieties, solutions for fruit borer and fungus disease, and seedling raising technologies (Figure 13). It is apparent that healthy seedling production technologies that include soil sterilization, netting to prevent pest/disease infestation, quality seeds, and other measures could increase production for a range of vegetable crops.



Figure 13: Tomato fields in Yenanchaung Township with diseases and fruit borer damage.

A wide range of insect pests and diseases were observed on farms in the Delta and the Dry Zone. Those on the following crops appear to be particularly serious:

- a. Yard-long bean: aphids (Figure 14), thrips, pod borer and viruses
- b. Radish and other crucifers: flea beetle (Figure 15) and caterpillars (*Hellula* sp. and others)
- c. Eggplant and pepper: whitefly (*Bemisia tabaci*) (Figure 16)
- d. Chili pepper: viruses, bacterial wilt and anthracnose (Figure 17)
- e. Cucurbits: Fruit flies (Figure 18), red pumpkin beetle (*Raphidopalpa foveicollis*)(Figure 19)
- f. Amaranth: *Spodoptera* sp. (Figure 20)



Figure 14. Aphids on yard-long bean in the Delta.



Figure 15. Flea beetles damage various crucifer crops.



Figure 16. Whitefly (*Bemisia tabaci*) numbers are high on eggplant in the Delta.



Figure 17. Anthracnose on chili pepper in the Delta.



Figure 18. Fruit flies infest various cucurbit crops.



Figure 19. Red pumpkin beetle (*Raphidopalpa foveicollis*) damages cucurbit crops extensively.



Figure 20. Armyworm (*Spodoptera* sp.) on amaranth in the Delta.

Individual farmer interviews

Unstructured interviews/discussions were carried out with farmers in their fields in Chauk, Yenanchaung, Pyapon, Bogale and Mawlamyinegyun Townships. In general, the information corroborated what was learned in the FGDs. The main content of these interviews can be found in Appendix 2.

Farmers with adequate water supply from wells in Chauk have profitable vegetable production operations in the cool season with relatively small amounts of land (usually well under 1 ha). More details on income levels, vegetable crops farmed, and related information is noted in Appendix 2.



Figure 21. Chauk farmer (third from left) the team interviewed.

Vegetable crops marketed and planted

A list of vegetable crops being sold in markets of Chauk, Yenanchaung, Pyapon and Bogale Townships, and crops planted in farms or home gardens of these townships plus Mawlamyinegyun, is included in Appendix 3.



Figure 22. Tomatoes grown by a Chauk farmer the team interviewed.

Conclusions

This scoping study focused on vegetable production constraints and opportunities, but also included some post-harvest, marketing and consumption issues. This study was not able to cover any of these areas comprehensively, due to limited team members, time and resources. More in-depth studies into all these areas, and nutrition and health as related to vegetables, are highly recommended and needed.

In the FGDs, respondents said they eat vegetables 2-3 times a day, so if there is underconsumption, perhaps it is not extreme. However, portion size and other key factors are not clear so further investigation into consumption and nutrition issues is definitely needed.

Farmers and household gardeners in Myanmar face a wide range of biotic, abiotic and socio-economic constraints. They also frequently expressed a need for more knowledge on a broad range of topics related to vegetable production, post-harvest handling and marketing. The recommendations noted below are key for alleviating their constraints and addressing their needs over the short and long term.

Myanmar farmers can be somewhat individualistic and not so willing to share knowledge, marketing channels and other information. This characteristic needs to be considered when providing training and making the common assumption that trained farmers will spread their new knowledge to their neighbors. WVM has found that farmers are not so willing to work with a group; this is related to local context and time availability. When a producer group is formed, they do not want to carry out collective selling because most farmers receive cash in advance from money lenders or traders. At harvest time, farmers must pay their produce to them instead of cash, so they are not able to join collective selling efforts.

Future projects could potentially be designed to implement any of the recommendations in this report, but some specific ideas are highlighted below:

- **Project objectives**
 - Increased resilience through improved economic livelihoods and sustainable environmental management for communities in the Dry Zone and Delta regions of Myanmar
- **Project outputs**
 - In both the Dry Zone and Delta
 - WorldVeg's heat-tolerant tomatoes introduced and technology package for growing tomatoes in the hot-dry season and the wet season promoted
 - The uptake pathway would emphasize collaboration with the private sector, especially seed companies, who would be encouraged to

- incorporate WorldVeg improved germplasm into their breeding programs and distribution plans
- WorldVeg’s improved lines of cucumber, bitter gourd, tomato and chili pepper introduced
 - Integrated Pest Management technologies introduced and promoted
 - Good agricultural practices promoted
 - Postharvest practices promoted
 - Community seed banks established
- Drought-tolerant vegetables introduced/promoted in the Dry Zone
 - Saline-tolerant vegetables introduced/promoted in the lower Delta
 - In saline areas, explore soil-less production with locally-available media such as coconut coir and rice husks

It is envisioned that participatory educational activities will be used to offer these innovations to household gardeners and commercial vegetable farmers to help them increase production through integrated pest management, balanced fertilization, seed-saving techniques, drip irrigation and other improved management technologies. Better post-harvest handling can also enhance value chain effectiveness. Participatory educational activities to promote vegetable consumption could also be carried out in Myanmar’s Dry Zone and Delta communities. These activities could include nutrition and health information, recipes and food preparation techniques.



Figure 23. Rat damage on bottle gourd in the Dry Zone.

Recommendations

Recommendations from Focus Group Discussion Data

<i>Constraints / problems</i>	<i>Immediate action</i>	<i>Midterm to long-term efforts*</i>
Limited access to quality vegetable seeds	<ul style="list-style-type: none"> ▪ Conduct training on seed saving and conservation (for open-pollinated lines only) 	<ul style="list-style-type: none"> ▪ Establish community seed banks ▪ Link reliable seed sector representatives to village farmers
Lack of knowledge on pest and disease management	<ul style="list-style-type: none"> ▪ Review current planting plan and implement rotation ▪ Conduct IPM training of farmers and extensionists 	<ul style="list-style-type: none"> ▪ Form farmers' groups as channels to continuously provide updated IPM information to farmers
Low soil fertility	<ul style="list-style-type: none"> ▪ Implement balanced fertilization practices, including crop rotation with green manure and composting ▪ Conduct training on balanced fertilization, including making and applying compost 	<ul style="list-style-type: none"> ▪ Link with local research institutes or extension offices to refine balanced fertilization and soil conservation guidelines
Water scarcity in hot-dry season	<ul style="list-style-type: none"> ▪ Apply mulching for vegetable production ▪ Plant drought tolerant vegetables ▪ Utilize low-cost drip irrigation systems 	<ul style="list-style-type: none"> ▪ Establish suitable rainwater harvesting techniques ▪ Evaluate how to most efficiently use simple drip irrigation systems
Lack of postharvest handling	<ul style="list-style-type: none"> ▪ Promote basic postharvest concepts and demonstrate simple techniques 	<ul style="list-style-type: none"> ▪ Establish vegetable collecting points to enable postharvest handling
Vegetable oversupply and fluctuating market prices	<ul style="list-style-type: none"> ▪ Conduct off-season vegetable production training for tomato and other crops 	<ul style="list-style-type: none"> ▪ Set up vegetable collecting points for supply control ▪ Establish transparent

<i>Constraints / problems</i>	<i>Immediate action</i>	<i>Midterm to long-term efforts*</i>
	<ul style="list-style-type: none"> Plant long-shelf-life varieties 	market demand and implement cooperative marketing
Soil salinity constrains vegetable production**	<ul style="list-style-type: none"> Bag vegetable farming (when fresh water for irrigation is available once every two weeks at Achar Kalay village) 	<ul style="list-style-type: none"> Test selected saline-tolerant vegetables locally Screen saline-tolerant rootstocks for future grafting
Lack of knowledge on vegetable production technologies	<ul style="list-style-type: none"> Conduct production technology training for selected vegetables 	<ul style="list-style-type: none"> Strengthen local agricultural extension function to continuously provide advice on vegetable production

*Further research and assessment for such recommendations are needed; based on preliminary results from interventions, recommendations will be further refined.

**In Pyapon and Bogale townships of Ayeyarwady Delta only.

Recommendations from all information sources

- 1) Commercial farmers in Seikphyu Township and other farmers in various locations have major constraints with producing tomatoes in the hot-dry season (March-May) and hot-wet season (June-October). We therefore recommend introducing WorldVeg's **heat-tolerant tomato lines** and conducting **multi-location variety trials with WorldVeg protocols**. A package of technologies to enable production in these seasons is recommended and would also include various combinations of **fruit-setting hormone, low-cost rain shelters, grafting, raised beds, seed-saving techniques** and possibly other technologies. WorldVeg has experience working with Bangladeshi farmers on hot-wet season tomato production; tomato prices are five times higher during this season than in the cool-dry season. Seeds of heat-tolerant tomatoes and other WorldVeg-improved vegetable varieties can be ordered from: <https://avrdc.org/seed/improved-lines/>.
- 2) Household gardeners and farmers in Chauk Township have problems with red clay soil that is infertile, hard, sticky, and difficult to work with (Figure 11). To mitigate these problems, they add sawdust and groundnut shells to the soil, but this is not enough. We therefore recommend making **compost with Acacia, chicken manure, groundnut shells and sawdust** (all these materials

are locally available); this can be utilized in both commercial fields and household gardens. Introduced and native Acacia species are locally abundant and will be a very good component for compost since Acacia is a nitrogen-fixing legume. The introduced Acacia is not well-liked by local people because it has longer thorns than the native species and is therefore difficult to handle (Figures 24 and 25). A wood chipper would help with breaking down the thorny branches to make them easier to handle. This can be a means to control the introduced, invasive Acacia and use this nitrogen-rich species advantageously.

- 3) Home gardens in Chauk are only productive during the rainy season due to water shortage the remainder of the year (Figure 12). We therefore recommend that **drought-tolerant vegetables be promoted or introduced to extend the gardening into the dry season** as much as possible. Drought-tolerant vegetable crops include amaranth, celosia, cluster bean, velvet plant, roselle, Indian mulberry, drumstick, perilla, purslane, sesbania, fragrant telosma, cowpea, tropical violet, Malabar spinach, spider plant and jute mallow, among others (Hsu 2011, Lin *et al.* 2009). Utilizing vegetable species that are less susceptible to drought stress, like perennials, is also advised. **Water saving technologies** are highly recommended, such as mulching, cover crops, other types of soil cover, planting in troughs and keyhole gardens.
- 4) Tomato farmers in Yenanchaung Township are requesting heat-tolerant varieties, solutions for fruit borer and fungus disease, and seedling raising technologies (Figure 13). In fact, healthy seedling production technologies are needed for a range of vegetable crops – **WorldVeg can provide training** on these.
- 5) Farmers in Yenanchaung, Bogale and elsewhere have problems with seeds they purchase not germinating or the number of seeds being very small even though they are in packets from reputable companies; problems with false/counterfeit seeds are apparently widespread. Therefore they are interested in technologies to **save and store their own seeds**, in particular for tomato, maize, yard-long bean, pumpkin, bitter gourd and okra. **WorldVeg has these technologies** for all the above except maize and has videos for tomato and pumpkin on our website and YouTube. Farmers in Bogale also expressed interest in **community seed banks**, which WorldVeg has experience establishing. Improvement of **private sector seed systems** is also recommended.
- 6) Farmers in Yenanchaung are interested in new varieties of cucumber, cauliflower and cabbage. WorldVeg has developed a number of **new cucumber varieties** and can provide these as shown in **our on-line seed catalog** (<https://avrdc.org/seed/improved-lines/cucumber/>).

- 7) Farmers in the Delta and the Dry Zone need integrated pest management (IPM) technologies for a wide range of insect pests and diseases on the following crops:
- Yard-long bean: aphids (Figure 14), thrips, pod borer and viruses
 - Radish and other crucifers: flea beetle (Figure 15) and caterpillars (*Hellula* sp. and others)
 - Eggplant and pepper: whitefly (*Bemisia tabaci*)(Figure 16)
 - Chili pepper: viruses, bacterial wilt and anthracnose (Figure 17)
 - Cucurbits: Fruit flies (Figure 18), red pumpkin beetle (*Raphidopalpa foveicollis*)(Figure 19)
 - Amaranth: *Spodoptera* sp. (Figure 20)

Diseases are apparent on a range of other vegetable crops such as tomato.

WorldVeg has IPM technologies to address many of these problems:

- Legume pod borer pheromones and a virus that specifically targets the pest
 - Tomatoes, peppers, pumpkins, bitter gourds and other vegetables with disease resistance
- 8) Household gardeners and farmers could try using a 1% solution of lemongrass oil to control various insect pests, since this caused 98% mortality of a caterpillar in Indonesia (Adnyana *et al.* 2012) and lemongrass is locally available.
- 9) Postharvest handling technologies are rare – no farmers or traders we interviewed use any postharvest handling methods to maintain vegetable produce quality, besides drying chilis. **WorldVeg has a number of low-cost methods** available.
- 10) Post-harvest processing could add value to harvested products, for example, roselle can be processed into juice.
- 11) Farmers in Pyapon Township are interested in open-pollinated (OP) varieties of tomato, yard-long bean, eggplant and bitter gourd. **WorldVeg has improved OP lines of tomato, bitter gourd, chili pepper and other vegetables** that can be introduced.
- 12) Salinity is a major constraint in parts of Pyapon and Bogale in the Ayeyarwady Delta. Saline water is not suitable for irrigation and from March through May (the hot-dry season) it is not possible to grow vegetables due to salinity. The wet season starts in June and flushes the salinity away enough to plant vegetables again. We therefore recommend promoting and/or introducing **saline-tolerant vegetables, especially for the hot-dry season**. Saline-tolerant vegetable crops include Ashitaba, cluster bean, Indian

mulberry, purslane, artichoke, asparagus, red beet, cowpea, zucchini squash, winged bean and celosia, among others (Lin 2011, FAO 2016).

- 13) During the wet season, flooding in parts of Pyapon and Bogale is not serious – maximum around 20cm – so **grafting with eggplant rootstocks could be effective to overcome constraints due to waterlogging and minor flooding.**
- 14) Farmers would like to learn how to grow vegetables during the wet season. In Kun Thee Chung, Bogale, introducing flood-tolerant vegetables would help them increase production during the wet season. Waterlogging-tolerant vegetables such as water spinach, jute mallow, Malabar spinach, and chickenspike are suggested, and training on how to grow these could be provided. Training on off-season production of global vegetables such as tomato and chili could also be provided after exploring further if there is sufficient interest.
- 15) Research on nutrition and health issues related to vegetables is highly recommended. It is unclear whether vegetable consumption is adequate. The level of awareness about the importance of vegetables for nutrition and health also needs further investigation.



Figure 24. Native acacia with short spines.



Figure 25. Introduced acacia with long spines.



Figure 26. Trader in Pyapon Market.

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Appendix 1. Semi-Structured Interviews of Vegetable Traders and Retailers

Note: 1.6kg is equivalent to a commonly-used local unit, the *peittha*, in Myanmar.

Chauk Market (Dry Zone), 13 Feb 2017

- 1) Is product quality a concern? What are the price differences for different product qualities?
 - Yes.
 - Tomato selling prices:
 - Good quality: 300 Kyats/0.5kg (USD 0.22)
 - Not good quality: 200 Kyats/0.5kg (USD 0.15)
 - Water spinach:
 - Good quality: 100 Kyats/5 bundles (USD 0.07)
 - Not good quality: 100 Kyats/8 bundles (USD 0.07)
 - Prices for different types of chili peppers:
 - Very small: 4000 Kyats/1.6kg (USD 2.92)
 - Longer: 2000 Kyats/1.6kg (USD 1.46)
 - Longest: 1500 Kyats/1.6kg (USD 1.09)

- 2) If product quality is a concern, what do you do to ensure good product quality?
 - She only collects good quality produce.

- 3) What are the lowest and highest prices (over the last 3 years) for the 3 vegetables you sell the most?

Vegetable	Highest price	Lowest price
<i>Marian plum (used in fish paste)</i>	10,000 Kyats/1.6kg (USD 7.30)	2000 Kyats/1.6kg (USD 1.46)
<i>Tomato</i>	2000 Kyats/1.6kg (USD 1.46)	100 Kyats/1.6kg (USD 0.07)
<i>Chili pepper</i>	15,000 Kyats/1.6kg (USD 10.95)	4000 Kyats/1.6kg (USD 2.92)

- 4) Where do you buy and sell these vegetables?
 - Farmers bring all produce here to her at this market.

- These farmers are from Kweibien Village, Hteinpin Village (both nearby) and Shan State
 - Produce from Shan State: tomato in the hot season because not available locally
 - She mostly sells here at this market but sometimes sells to another retailer
- 5) Do middlemen have binding agreements with farmers so that farmers cannot sell their vegetables freely?
- No middlemen – all farmers sell directly to her
- 6) What are the price differences between the farm gate price (of vegetables bought from the farmer) and those sold in the market?
- She would not tell us how much she marks up the price from what she pays farmers

Yenanchaung Market (Dry Zone), 15 Feb 2017

Owner: female

- 1) Is product quality a concern? What are the price differences for different product qualities?
- Yes, she only sells good quality produce
- 2) If product quality is a concern, what do you do to ensure good product quality?
- Choose by sight only the high quality produce
 - No problem with maintaining quality overnight, because usually all vegetables are sold out by 6pm; her stall opens at 4:30am
- 3) What are the lowest and highest prices for the 3 vegetables you sell the most (over the last 3 years)?

Vegetable	Highest price	Lowest price
<i>Potato</i>	<i>1800 Kyats/1.6kg (USD 1.32)</i>	<i>1000 Kyats/1.6kg (USD 0.73)</i>
<i>Chili (smallest variety)</i>	<i>12,000 Kyats/1.6kg (USD 8.76)</i>	<i>2000 Kyats/1.6kg (USD 1.46)</i>
<i>Pea pods</i>	<i>6000 Kyats/1.6kg (USD 4.38)</i>	<i>2000 Kyats/1.6kg (USD 1.46)</i>

- 4) Where do you buy and sell these vegetables?
 - She goes to Kyaukpadaung Township every day at 4am and personally chooses and buys. At 12:00 noon the new vegetables arrive here. She buys from a wholesaler.

- 5) Do middlemen have binding agreements with farmers so that farmers cannot sell their vegetables freely?
 - She does not know about this

- 6) What are the price differences between the farm gate price (of vegetables bought from the farmer) and those sold in the market?
 - Not so big a difference. For example, if she buys an item for 1000 Kyats from the wholesaler, she may sell it at 1200 Kyats.

Pyapon Market (Delta region), 17 Feb 2017

Seller: female

- 1) Is product quality a concern? What are the price differences for different product qualities?
 - She is concerned about quality. She sells low quality chili pepper at 1000 Kyats/1.6kg (USD 0.73) and good quality pepper at 1500 Kyats/1.6kg (USD 1.10).

- 2) If product quality is a concern, what do you do to ensure good product quality?
 - She doesn't do anything to maintain quality. She only sells produce for 2 days, after that throws it away. Most days she can sell everything.

- 3) What are the lowest and highest prices for the 3 vegetables you sell the most (over the last 3 years)?

<i>Vegetable</i>	<i>Highest price</i>	<i>Lowest price</i>
<i>Small green mango</i>	<i>300 Kyats/fruit (USD 0.22)</i>	<i>50 Kyats/fruit (USD 0.04)</i>
<i>Tomato</i>	<i>2500 Kyats/1.6kg (USD 1.83)</i>	<i>600 Kyats/1.6kg (USD 0.44)</i>
<i>Sweet corn</i>	<i>200 Kyats/cob (USD 0.15)</i>	<i>80 Kyats/cob (USD 0.06)</i>

- 4) Where do you buy and sell these vegetables?
 - She buys in Yangon directly from middlemen and sells here. She goes to Yangon every day, departing Pyapon at 6pm and arriving in Yangon at 8:30pm. At 2am she leaves Yangon and arrives back in Pyapon at 6am. The stall is closed from 10am to noon.
 - Some farmers in nearby townships bring produce here and sell to her directly, especially chili pepper, mango and sweet corn.
- 5) Do middlemen have binding agreements with farmers so that farmers cannot sell their vegetables freely?
 - No agreements are binding that she knows about.
- 6) What are the price differences between the farm gate price (of vegetables bought from the farmer) and those sold in the market?
 - About 40% markup from farmgate price to market

Pyapon Market (Delta region), 17 Feb 2017

Seller: male

- 1) Is product quality a concern? What are the price differences for different product qualities?
 - He is concerned about quality. He sells low quality cabbage at 400 Kyats/head (USD 0.29) and good quality cabbage at 800 Kyats/head (USD 0.58).
- 2) If product quality is a concern, what do you do to ensure good product quality?
 - He doesn't do anything to maintain quality, but he throws the produce away if the quality is bad.
- 3) What are the lowest and highest prices for the 3 vegetables you sell the most (over the last 3 years)?

Vegetable	Highest price	Lowest price
<i>Long chili pepper</i>	<i>1800 Kyats/1.6kg (USD 1.31)</i>	<i>1000 Kyats/1.6kg (USD 0.73)</i>
<i>Tomato</i>	<i>1200 Kyats/1.6kg (USD 0.88)</i>	<i>800 Kyats/1.6kg (USD 0.58)</i>
<i>Cucumber</i>	<i>500 Kyats/10 cucumbers (USD 0.37)</i>	<i>400 Kyats/10 cucumbers (USD 0.29)</i>

- 4) Where do you buy and sell these vegetables?
 - He buys from Yangon Market – he travels there in a public car every day.
 - He opens this stall at 5am and closes at 11am.
 - No farmers come here to sell to him.

- 5) Do middlemen have binding agreements with farmers so that farmers cannot sell their vegetables freely?
 - No response

- 6) What are the price differences between the farm gate price (of vegetables bought from the farmer) and those sold in the market?
 - 15-20% difference between farmgate price and his selling price (*Note: Kyaw Zin doubted whether he was answering truthfully*)

Bogale Market (Delta region), 20 Feb 2017

Seller: female

Myomazeygyi Market

- 1) Is product quality a concern? What are the price differences for different product qualities?
 - She is concerned about quality. She may sell good quality produce for 1000 Kyats (USD 0.74) and not good quality produce for 500 Kyats (USD 0.37).

- 2) If product quality is a concern, what do you do to ensure good product quality?
 - She does not take any measures to ensure good quality

- 3) What are the lowest and highest prices for the 3 vegetables you sell the most (over the last 3 years)?

<i>Vegetable</i>	<i>Highest price</i>	<i>Lowest price</i>
<i>Coriander</i>	<i>600 Kyats/10 bundles (USD 0.44)</i>	<i>400 Kyats/10 bundles (USD 0.30)</i>
<i>Chili pepper</i>	<i>1500 Kyats/1.6kg (USD 1.11)</i>	<i>1200 Kyats/1.6kg (USD 0.89)</i>
<i>Bamboo shoots</i>	<i>1200 Kyats/1.6kg (USD 0.89)</i>	<i>1200 Kyats/1.6kg (USD 0.89)</i>

- 4) Where do you buy and sell these vegetables?
 - She collects and buys these from village farmers once every 2 days.
 - A middleman not far from here collects once every 2 days.
 - She also orders produce from Yangon Market.
- 5) Do middlemen have binding agreements with farmers so that farmers cannot sell their vegetables freely?
 - No binding agreement with farmers.
- 6) What are the price differences between the farm gate price (of vegetables bought from the farmer) and those sold in the market?
 - About 20% markup from farm gate price.

Bogale Market (Delta region), 20 Feb 2017

Seller: female

Ahrkhonlud Market or Free Tax Market

- 1) Is product quality a concern? What are the price differences for different product qualities?
 - She is concerned about product quality and price. She may sell good quality produce at 50 Kyats and bad quality at 25-30 Kyats, for example.
- 2) If product quality is a concern, what do you do to ensure good product quality?
 - She does nothing to maintain quality; she just tries to sell quickly.
- 3) What are the lowest and highest prices for the 3 vegetables you sell the most (over the last 3 years)?

<i>Vegetable</i>	<i>Highest price</i>	<i>Lowest price</i>
<i>Chili pepper</i>	<i>4000 Kyats/1.6kg (USD 2.95)</i>	<i>1200 Kyats/1.6kg (USD 0.89)</i>
<i>She did not provide any further information here</i>		

- 4) Where do you buy and sell these vegetables?
 - She buys from Yangon Market – she goes herself by car.
- 5) Do middlemen have binding agreements with farmers so that farmers cannot sell their vegetables freely?
 - No binding agreements.
- 6) What are the price differences between the farm gate price (of vegetables bought from the farmer) and those sold in the market?
 - 20% rise in price from farm gate

Appendix 2. Farmer and Farm Visits: unstructured interviews and direct observations

Note: All points below are from the farmer, except for our observations, which are marked: *

Home garden visit, Chauk, 13 Feb

- Family sells most of the vegetables produced, because only 3 people at home
- Vegetables planted year-round: papaya, drumstick tree, pumpkin, amaranth
- Pumpkin
 - She gets seeds from a neighbor, who saves the seeds
 - They eat the shoots, leaves and fruits; usually fried
 - Grown year-round, no pests and diseases
- No water constraints
 - She has a tube well with a pump and municipal water
- Amaranth needs watering during dry season
- Drumstick tree
 - They eat leaves, flowers and fruits once a week
 - She sells the fruits
- Family eats vegetables twice a day
 - They buy some from the market, including potato, tomato, chili and yard-long bean; these are not grown at home due to lack of free time
- Fruit flies are a problem on guava but not pumpkin
- Small eggplant is also grown and eaten
- Small chili pepper also grown and consumed
- Leguminous tree grown and pods consumed
- Neem leaves from neighbor's tree consumed

Home garden visit, Chauk, 13 Feb

- She grows mustard (various kinds), Chinese cabbage, salad (lettuce), kailan, Chinese coriander
- She sells 2/3 of vegetable produce and consumes 1/3
- She makes the most money from white mustard
- Family likes to eat mustard (regular kind)
- Leaf borer is a problem on mustard
- These crops are only planted in winter and overall pest problems are minimal
 - crop rotation appears to be a major cause in keeping pest problems down*
- Hot-dry season: she plants water spinach and roselle
- Rainy season: water spinach

- Aphids are a problem on bitter mustard
 - They use imidacloprid pesticide on it, which controls the pest
- Drumstick tree
 - A middleman collects the fruit, which is sold in Yangon
- Kailan and mustard are prepared in seedbeds after the rainy season
- She makes 35,000 Kyats (~USD 26) per week during the winter season, when many crucifers are planted

Home garden visit, Chauk, 13 Feb

- Winter vegetables grown: mustard, salad (lettuce), kailan, Chinese coriander, tomato, edible chrysanthemum
- Tomato
 - Too much shade, so the farmer is not satisfied
 - He harvested and sold 60kg already at 700 Kyats/kg (USD 0.51/kg), which is a good price compared to last year
- He makes about the same amount of money from all the above crops
 - Total about 70,000 Kyats/week (USD 51/wk) in winter, for 4 months/year
- The rest of the year he plants water spinach, roselle, drumstick and mint
 - Income is 28,000 Kyats/week (USD 20/wk)
- He sells 90% of his vegetable produce and the family consumes 10%
 - 9 family members
- No chemical pesticides or fertilizers used for the past year
 - Previously used 'Folidol' (a chemical pesticide)

Demonstration Plot #1 in WVM's Chauk Area Development Program, 14 Feb

- Naywetaw Village, Chauk Township
- Demo plot relies on water catchment constructed by WVM
- Water table is 700 feet (213 meters) below the surface here
 - Since it is so deep, WVM encourages people to catch water rather than depend on tube wells in this location
 - Then encouraged to water their home gardens from catchments
- Cost of tube well to 900 feet: USD 25,000
 - Government provides one per village from JICA funds
- Water from these deep tube wells is not good for vegetable gardens
 - Salty and has high iron content
- Demonstration plot started in Dec 2016
 - Yard-long bean grows well in all seasons (cool, hot-dry and wet)
 - Problem with fungus – farmer tries to control it with neem (but this may not work*)
 - Another natural fungicide formulation is available but he has not used it yet – learned it from training
 - Rats damage yard-long bean

- Bitter gourd grows best in wet season
- Bottle gourd
 - People eat fruits and shoots
 - Farmer leaves it on ground (no trellis) in dry season
 - On bamboo poles in wet season
 - Rats damage bottle gourd
- Tomato grown
- Radish planted too late
 - Flea beetle attacking it
 - Farmer trying neem, but not sure if it works
- Farmer uses natural pesticides at the request of WVM staff
- Farmer's first sale from this plot was coriander: 6000 Kyats (USD 4.38) for about 5kg
- Sweet potato: people mainly eat the tubers

Demonstration Plot #2 in WVM's Chauk Area Development Program, 14 Feb

- Water catchment built by WVM covers 5 acres (~2 ha)
 - Water used for demo plot, animal drinking, household utilization (washing and bathing but not drinking)
 - Oct-Nov it hits peak level of 12 feet deep; currently 3 feet (~1m) deep
- Demo Vegetable Farm
 - Initiated Dec 2016
 - Farmer: male
 - tomato, yard-long bean, roselle, okra, eggplant, ridge gourd, cucumber
 - nothing harvested yet – too early
 - Main constraint: red, sticky clay soil becomes dry and hard after watering
 - Recommendation*: add compost made of Acacia (native and introduced varieties), other green manure, animal manure, groundnut shells and sawdust, since all are locally available
 - The native Acacia variety has shorter thorns and is therefore easier to work with
 - The introduced Acacia variety has longer thorns so it is more difficult to work with and the local people consider it a nuisance
 - Recommendation*: invest in a wood chipper to help break down thorny Acacia branches for composting; this can become a means for controlling the introduced Acacia
 - Pigeon pea appears to grow the best, among the crops in the area
 - Recommendation*: Residual vegetation after harvest could be used as green manure or compost

- Many farmers in the area are intercropping pigeon pea with groundnut or green gram (mungbean)

Demonstration Plot in WVM's Yenanchaung Area Development Program, 15 Feb

- Nyaungzaukchaung Village, Yenanchaung Township
- 11 tube wells only 20 feet (~6 meters) deep were hand-dug (in Dec 2016) and are effective since there is a stream nearby in the rainy season
- Demo plot established in Dec 2016
 - Yard-long bean, tomato, chili pepper, winged bean, cucumber, ridge gourd, okra, bitter melon, pumpkin, roselle, radish, coriander
- Farmers are planting vegetables independently nearby
 - Onion, groundnut, maize
 - Testing winter crops
 - These farmers have taken the concepts from the WVM demonstration plot and moved forward independently
- Tomato farmer: male
 - This is the first time he planted tomato
 - Constraints:
 - watering is labor-intensive
 - fungus makes the leaves brown, this started after the wet season stopped about 2 months ago
 - he uses the fungicide 'Unity' and buries diseased plants
 - problems with fruit borer*
 - he applies fertilizer:
 - 15-15-15 NPK compound fertilizer used 4 to 5 times
 - top dressing at base of each plant, 5g each in earlier applications, progressing to 10g and then 15g later in the season
 - foliar fertilizer "Tesembwa" used once a week
 - He is satisfied with the yield in the wet season, but not satisfied in the hot-dry season because it drops
 - Recommendation*: introduce WorldVeg's heat-tolerant lines
 - He made ~200,000 Kyats (USD 147) in ~7 months, from July 2016 – Feb 2017
 - Harvested in Sept – Feb
 - Seeds from Yenanchaung supplier
 - He is not sure these are the "right varieties"
 - At first the project provided seedlings, later he bought them
 - He needs seedbed and seedling preparation technologies

Home/commercial garden visit, Yenanchaung, 15 Feb

- Farmer: female
- Ywar Thit Gyi village, Yenanchaung Township
- She started this garden 3 months ago
- Had previous experience growing onion and maize
- Purpose of garden: to have income for her children
- 10% of vegetables are consumed at home, 90% sold
- She made 30,000 Kyats (~USD 22) so far from this garden (in 3 months)
- She would like to expand and increase production
 - Planning to level the lower part by adding soil
 - Will add roselle, water spinach, sweet potato and mustard
- Easiest vegetables to grow: roselle, pumpkin
- Hardest: none
- Constraints:
 - Weeds, controlled by manual digging
 - Yard-long bean: aphids
- She eats vegetables every day, 2 times a day
 - Her family likes all kinds of vegetables
- She buys all her seeds at Yenanchaung market: all are good quality
- Middleman comes here to buy her produce
- She does the harvesting, but uses no postharvest handling methods
- Recommendation*: simple, low-cost postharvest methods could increase quality
- She is satisfied with the prices she gets
- Fertilization: cow dung and small amounts of compound fertilizer

Home/commercial garden visit, Yenanchaung, 15 Feb

- Farmer: male
- Started 1 month ago farming water spinach, chrysanthemum, onion, pumpkin and roselle
- Mustard harvested already
 - Planted in October, harvested in December 2016
 - 100% consumed by family and neighbors
- He wants to sell future harvest
 - 90% sell, 10% consume
- Seeds were bought from Wattafor Company in Magway 38 miles away
 - Seeds were delivered here
 - He is satisfied with their quality
- Plowed land, sowed manually, added cow dung
- He wants to add urea fertilizer later

Visits to farmers' fields in Pyapon Township, 17 Feb

- In some cases, the farmer was not present
- Constraints identified*:
 - Armyworm (*Spodoptera* sp.) defoliating amaranth
 - Whiteflies (*Bemisia tabaci*) attacking cucurbits
 - Viruses or other diseases on cucurbits
 - Armyworm (*Spodoptera* sp.) attacking cucurbits
 - Leafhoppers (Cicadellidae) attacking eggplant
 - Virus attacking chili pepper
- Recommendation*: try using a 1% solution of lemongrass oil to control various insect pests, since this caused 98% mortality of a caterpillar in Indonesia (Adnyana *et al.* 2012) and lemongrass is locally available

Visit to farmers' fields in Pyapon, 18 Feb

- First field was planted in 7 Feb 2017 but this farmer has 2 years' experience with vegetables
 - Yard-long bean, tomato, radish, cucumber, lettuce, mustard, bitter gourd
 - Pest/disease problems:
 - Especially during flowering periods
 - Leaves turn yellow
 - Red Pumpkin Beetle (Chrysomelidae) defoliating cucumber*
 - Flea beetles on mustard*
- Second field in need of more regular irrigation and has similar pest/disease problems

Visit to a farmer's field in Pyapon, 18 Feb

- Farmer: male (who was a very vocal participant in FGD 5)
- He is very positive about a traditional vegetable called "Hingala"
 - They eat the leaves
 - Looks like African spider plant (*Cleome gynandra*)
- He says that there is a "window" a few days long every two weeks (approximately), in which a nearby river has fresh water; the rest of the 2-week period, salt water encroaches from the ocean
 - This cycle runs according to the ocean tides
 - He pumps fresh water from the river during the "window" and uses it for 15 days
- He is planting vegetables in a fairly large field (approx. 1 ha)
- Constraints observed*:

- Chili pepper: anthracnose, bacterial wilt (?), virus, armyworm, fruit borer
- Yard-long bean: virus, thrips
- Okra: virus
- Crucifers: flea beetle
- Eggplant: whitefly

Visit to a farmer's field in Bogale, 19 Feb

- Farmer: female
- Mayankwel Village, Bogale Township
- Started this vegetable garden 3 months ago, but has experience with home gardening for many years
- Has problem with orange beetle damaging amaranth
- She makes bokashi out of pumpkin and sprays it to control pests
- Easiest vegetables to grow: yard-long bean, roselle, cucumber, okra, bottle gourd
- Yard-long bean has not done well, however, due to pest damage
- She has collected seeds of yard-long bean, okra and cucumber
 - Sun dries them for 3 days and selects good quality ones
 - Stores them in glass bottles
 - 80-90% germinate after 3 months
- Constraints observed*:
 - Okra: leafhoppers
 - Chili pepper: virus, aphids, bacterial wilt (?)
- Recommendation*: try 1% lemongrass oil solution to control insect pests

Visit to farmers' fields in Bogale, 19 Feb

- Farmers: male
- Easiest to grow and produce well: bottle gourd, pumpkin, yard-long bean
- Constraints observed*:
 - Eggplant: whitefly
 - Amaranth: defoliation by unknown pest
 - Crucifers: flea beetle
 - Yard-long bean: aphids
 - Cucurbits: fruit fly
- He does not use any pest control measures because these vegetables are for family consumption
- Recommendation*: try using 1% lemongrass oil solution to control insect pests

Visit to farmers' fields in Mawlamyinegyun Township, 20 Feb

- Mazeli Tel Kone Village
- In general, this area is much more prosperous than Bogale and other field sites we visited during this scoping study, and vegetable production is very good here

Appendix 3: Vegetables sold in the markets and those grown on farms or in household gardens

Vegetables sold in the markets					Vegetables grown on farms or in household gardens							
Region/ Township/ Village	Dry Zone		Ayeyarwady Delta		Dry Zone			Pyapon		Bogale	Mawlamyinegyun	
Vegetable crops	Chauk	Yenan-chaung*	Pyapon	Bogale	Seikphyu	Nayweltow, Chauk	Ywar Thit Gyi, Yenan-chaung	Shan Kwin Gyi	Achar Kalay	Kun Thee Chung	Mazeli Tel Kone	
Tomato	x	x	x	x	x	x	x					
Ridge gourd						x	x					
Bottle gourd-fruit	x		x	x	x	x	x	x	x			
Cabbage	x	x	x	x	x							
Coriander	x		x	x	x	x					x	

Vegetables sold in the markets					Vegetables grown on farms or in household gardens							
Corn			x				x					
Cowpea							x					
Eggplant-green long fruit			x	x		x		x		x		
Mustard								x				
Mallow squash							x					
Onion			x	x		x						
Potato	x	x		x			x					
Pumpkin-fruit	x		x				x	x			x	
Vegetable Soybean							x					
Acacia	x		x	x								
Angled/ridge gourd			x									
Bamboo shoots			x	x								

Vegetables sold in the markets					Vegetables grown on farms or in household gardens							
Banana bud	x		x									
Banana stem	x											
Beansprouts	x			x								
Bell pepper-green			x	x								
Bottle gourd-shoots/vines	x			x								
Broccoli	x											
Caluliflower	x	x	x	x								
Carrot	x	x	x	x								
Centella			x	x								
Chayote (fruits)		x		x								
Chili pepper-dried			x	x								
Chili pepper-fresh	x	x	x	x	x	x			x		x	

Vegetables sold in the markets					Vegetables grown on farms or in household gardens								
Chinese cabbage	x	x	x										
Eggplant-green round fruit	x			x									
Eggplant-purple long fruit	x		x	x									
Eggplant-purple round fruit	x		x	x									
Eggplant-white round fruit			x	x									
Gandaria (fruits)			x	x									
Garlic		x	x	x									
Ginger	x	x	x	x									
Green mango	x		x	x									
Green onion	x												
Green papaya		x	x										

Vegetables sold in the markets					Vegetables grown on farms or in household gardens								
Jackfruit			x										
Kale	x												
Kohlrabi	x												
Lablab bean			x										
Lemongrass			x	x									
Lettuce	x			x									
Lima bean		x											
Luffa gourd/sponge gourd	x												
Mint	x												
Moringa/drumstick-young pods			x	x									
Neem	x		x	x									

Vegetables sold in the markets					Vegetables grown on farms or in household gardens								
Pak choy			x	x									
Pumpkin-shoots/vines				x									
Shallot				x									
Snap bean/French bean	x	x											
Snow pea/garden pea	x	x											
Spiny coriander			x	x									
Tamarind (fruits)			x										
Tamarind (leaves)	x												
Watercress		x											
Water mimosa				x									
Wax gourd			x	x									

Vegetables sold in the markets					Vegetables grown on farms or in household gardens							
Winged bean	x		x									
Amaranth			x	x		x		x		x		
Bitter gourd-shoots/vines				x						x		
Sweet potato									x			
White radish	x		x		x	x	x	x	x	x	x	x
Bitter gourd-fruit	x		x	x		x	x	x	x	x	x	x
Kangkong/water spinach	x		x	x		x	x	x	x	x	x	x
Okra	x		x	x	x			x	x	x		
Roselle	x		x	x		x	x	x	x	x	x	x
Snake gourd								x				x
Yardlong bean	x		x	x	x		x	x	x	x	x	x

Vegetables sold in the markets					Vegetables grown on farms or in household gardens							
Cucumber			x	x					x	x	x	x
Total number of types	38	15	45	44	10	16	11	10	11	10	9	

*Number of vegetables sold in Yenanchaung Market may be biased towards the low end and unrepresentative, because we visited this market late in the afternoon, when most stalls had already closed.



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