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IMPROVING ENERGY AND RESOURCE EFFICIENCY IN GREENHOUSE CULTIVATION IN KOSOVO PROJECT

DELIVERABLE #1: OVERVIEW OF GREENHOUSE SITE VISITS

April 29, 2019

This report was produced for review by the United Agency for International Development. It was prepared by Agritecture, Subcontractor, and Crimson Capital Corp., Prime Contractor.

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ACRONYMS

FT	Full time
GH	Greenhouse
ha	Hectare
kg	Kilogram
kWp	Kilowattpeak
IADK	Initiative for Agricultural Development of Kosovo
MAFRD	Ministry of Agriculture, Forestry and Rural Development
M^2	Meters squared
PE	Polyethylene
USAID	United States Agency for International Development

BACKGROUND

The Improving Energy and Resource Efficiency in Greenhouse Cultivation in Kosovo program (the Program) is a USAID-funded, 13-month long project that is designed to research and bring to light improvements in technologies for greenhouse cultivation in Kosovo and how to finance them in two primary areas: (1) Renewable Energy Technologies; and (2) Hydroponics; in a format that is accessible, practical and usable for Kosovo's greenhouse operators.

The Program will:

1. Conduct an overview, sampling 10 greenhouses in Kosovo
2. Develop an assessment of renewable energy technologies and hydroponics
3. Develop Optimal Technological Packages for the 10 greenhouses sampled
4. Create a Toolkit for greenhouse operators in Kosovo of technologies for renewable energy and hydroponics, providing practical guidance on potential options for how to source financing for these technologies
5. Provide support to select greenhouse operators in accessing finance
6. Produce a Study Report compiling data and information gathered from activities 1-5 above

This report covers item 1 of the Program. Greenhouse site visits were conducted in Kosovo during the period March 4-16, 2019. The Project Team conducting the greenhouse site visits consisted of the following:

- Ismet Babaj (Country Agriculture Expert, Crimson)
- Arian Lila (Country Finance Expert, Crimson)
- Pellumb Gjinolli (County Energy Expert, Crimson)
- Jeffrey Landau (International Renewable Energy Expert, Agritecture)
- David Ceaser (International Hydroponics Expert, Agritecture)

All of the interviews held were conducted in Albanian and translated to English by the Country Experts for the International Experts.

PURPOSE

The purpose of the Program is to research and bring to light improvements in technologies for greenhouse cultivation in Kosovo and how to finance them in two primary areas: (1) Renewable Energy Technologies; and (2) Hydroponics; in a format that is accessible, practical and usable for Kosovo's greenhouse operators.

The hypothesis is that if technologies for reducing energy costs, reducing natural resource use (energy/water) and improving energy reliability in greenhouse production in Kosovo are better understood by greenhouse operators, combined with a better understanding of how to finance these technologies, then greenhouse operators in Kosovo will be more likely to uptake these technologies and the overall efficiency of greenhouse production in Kosovo will be improved.

In order to test this hypothesis, field research was conducted to better understand the technologies currently used by greenhouse farmers in Kosovo. Interviews were conducted with 10 different greenhouse farmers to better understand their operations and the challenges they face as they seek to expand and grow their businesses.

GREENHOUSE SITE VISITS OVERVIEW

While each greenhouse operation the team visited was unique in its own way, there were many similarities noted across all operations. These similarities provide a solid basis of understanding for the general greenhouse industry in Kosovo. These similarities include:

Component	*Observation*
Crops	There was little variation in the crops grown. Crops grown by operators in greenhouse or tunnel production were: tomatoes, cucumbers (salad & pickling), peppers, lettuce, melons, spinach, strawberries, plant starts and ornamental plants.
Electricity & Wi-Fi	Most greenhouses have electricity and many have Wi-Fi coverage. All operators use a smartphone for researching weather conditions and other research (market prices, pest research, etc.) but none used any smart phone based apps for agriculture. Few operators understood English. Many have children who speak/understand English at a basic level.
Environmental Monitoring	All of the operators monitor temperature and humidity of greenhouses based on "feel". A couple of the operators did have manual hygrometers in their greenhouses, but didn't rely on them for monitoring.
Heating	Temporary heating: All operators noted the need for a temporary solution to the occasional freezes that occur in the early spring and fall (March, April & October). This could be a temporary heating solution or a temporary cold protection solution. The need for this solution ranges from 7-21 days per year, depending on weather specifics. Many expressed the desire to use floating row covers (called "fleece" by the Country Agriculture expert) to be able to transplant earlier in the season, but are reluctant to pay for it.
Hydroponics	None of the operators use hydroponic production. Many were aware of hydroponics from the internet or from visiting operations in Turkey, Macedonia, Holland, Germany or Switzerland. Several operators are interested in trying hydroponics while others feel that agriculture in Kosovo is not ready for this advancement.
Insect Netting & Floating Row Covers	Insect netting and floating row covers were two items that most operators wish they had, but said they could not afford. A program by the government or a non-profit institution that would purchase these items in bulk and re-sell at cost could provide significant value to farmers and the Kosovar agricultural sector as a whole.
Method of production	All operators use in-ground cultivation for vegetable production. Ornamental production is done in flats and pots. Some operators use tractors in their greenhouses and tunnels for cultivation and bed shaping while others use a rototiller. Tractor use is generally limited only by the size or geometry of the tunnel or greenhouse.
Ownership & Labor	All operations visited were owner-operated and all used family labor for more than 50% of labor needs. In most cases, labor needs were fulfilled by family members, with additional labor hired as needed during peak labor periods such as at seeding, transplanting and harvest times. Several operators mentioned that it was extremely difficult to find labor help when needed. It is not clear if this labor shortage is a result

	of a lack of interest in agricultural work or in combination with the prevailing pay rate for agriculture of €15 per day.
Operator History & Training	All the operators had grown up farming. Their use of tunnel and greenhouse production has begun since the late 1990's or early 2000's. Most operators have done some sort of training to learn about greenhouse / tunnel cultivation.
Pest Management	None of the operators have insect screening installed on sidewall vents. Many expressed the desire for this to combat spider mites, thrips and tuta absoluta - the most common insect issues described by the growers. Cost was the prohibitive issue.
Record Keeping	Most information reported by farmers was anecdotal. Only at the first greenhouse did the operator have written records, which he used to answer questions. At all the other operations, farmers answered "off the top of their heads". Thus, it is unclear the accuracy of the information given, especially when referring to crop prices and profitability.
Seedlings	All Operators visited are producing their own seedlings. The team observed at some farms issues of quality with seedling production. Proper seedling development is very important in commercial crop production and greatly affects the quality and yield of crops.
Shape	There were two structure shapes that were seen at the operations that we visited. The main greenhouse type is an arch type greenhouse. These structures have straight walls and an arched roof (Figure 1). Most greenhouses had a minimum of 2-3 bays while some had up to 10. The other greenhouse structure commonly seen was a tunnel. Tunnels are smaller in size and used for seedling and crop production.
Structure	All greenhouses that the Team visited are steel frame structure with polyethylene (PE) covering. While the majority of greenhouses had a single layer of PE, some greenhouses had a double layer.
Substrates	All the operators use a commercial substrate for seedling production. The most commonly used substrate is produced in Germany by a company called Klasmann-Deilmann.[1] While the substrate being used is of high quality, there is a potential opportunity for domestic production of substrate through a mixture of coco coir and worm castings. Domestic production could achieve several goals for Kosovar farmers and society: ● Reduce input costs through reduced substrate costs. ● Create local jobs through substrate production. ● Reuse organic waste materials being generated in cities in combination with manure waste from farms.
Ventilation	None of the greenhouses had any ventilation other than manually opening sidewall vents and opening doors at either end. All operators expressed frustration with heat and humidity issues, especially during the summer months.

[1] More info on their products can be found: https://klasmann-deilmann.com/wp-content/uploads/KD_Broschuere_EasyGrowing_01_18_EN.pdf

Water Usage	None of the Operators track water use. Since most Operators use well water, they consider it to be "free" and don't track the usage.
Wastage	Wastage is not tracked. Most Operators commented that it was generally between 1-3% unless there was a specific pest outbreak, which can decimate an entire crop.

Figure 1: Typical gutter connected arch style greenhouse common in Kosovo

GREENHOUSE # 1

Date of visit: March 4, 2019
Location: Davidvc / Shtime

Ownership & management
This farm is owned and managed by Halim Baftiu. Mr. Baftiu is 56 years old and has a high school education with a focus on economics. His business is called Bio Fruti and is one of the only Operator visited that has a website (https://www.facebook.com/BioFruti1). He also contracts with a local agriculture consultant for specific advice.

Type of structure
Arch style greenhouse with framing made of galvanized steel and PE plastic sheeting covering.

Size of structure

Halim has various greenhouses and tunnels as part of his farm with a total area of 0.5 ha. Total farm size is 3 ha.

Current heating systems and costs

This operation uses a heating system to heat two structures located closest to the heating system. One structure is a small tunnel used for seedling propagation and plant starts (300 M^2). The other is a greenhouse containing ornamental plants (1,000 M^2). The heating system burns coal/lignite and wood, which heats water. Hot water is then pumped through black plastic pipe, which is located underneath the trays of plants in the greenhouse. The heating system costs approximately €2,500 - €3,000 per year to heat the two covered spaces at night. Typically, heating is used at night for 5-6 months per year. So, it can be assumed that the heating cost is approximately €500 per month while in use. Greenhouse temperatures are not monitored at this operation, so it is not clear how much the heating system is increasing nighttime temperatures.

Other modifications for heat retention include a second ceiling in the ornamental greenhouse and floating row covers. This is an extra layer of plastic running horizontally at approximately 6' height for additional heat retention.

Current irrigation / water systems and costs

Irrigation is done via two methods. Sprinkler irrigation is used for ornamentals and lettuce. Drip irrigation is used for strawberries, tomatoes, peppers and cucumbers. Water is sourced from an on-site well. The irrigation pump is powered by a 10 kWp solar array that cost €12,000 and was part of the original grant described in the financing section below.

Labor model and structure

The operation uses 4 full-time (FT) employees plus 4 family members - 2 FT, 2 half time. The operation also employs 3 FT seasonal helpers in April for flowers, June for strawberries, and September for pickling cucumbers.

Description of growing / cultivation methods

Ornamental plants are seeded in flats and transplanted to pots for growing out and sale. Some ornamentals are purchased as seedlings in flats and re-potted and grown out for sale. Potted plants are held in flats and placed on wood slats to maintain slightly elevated height. Vegetable crops are grown in the ground inside the greenhouses.

Figure 2: Primroses on wooden slats in greenhouse. Radiant heating is located under the wooden slats to heat air under plants. The metal rebar cutting diagonally through image is a frame allows for covering with plastic or floating row cover for additional heat retention.

Pest issues and pest management

The main pest issue is spider mites on cucumbers. The Operator wants insect screening for his greenhouse sidewall vents but does not have any. Botrytis (fungal disease) on lettuce is another issue. This occurs because of lack of ventilation and difficulty managing humidity. Typical losses due to botrytis are <5%.

Nutrient usage and management

The Operator uses pressed chicken manure (Italpollina 4:4:4+70.7 OM - https://italpollina.com) and dry fertilizer in addition to fertigation. Salts were seen on soil surface, which can mean an excess of fertilizer use.

Wastage Amounts

Not tracked.

Crops produced & average prices

Crop	Price	Season/ Notes
Tomato	0.7 €/kg	Early season
	0.4 €/kg	Wholesale
	0.5 €/kg	Retail
Pepper	1.0 €/kg	Beginning of season
	0.6 €/kg	Mid-season wholesale

Strawberry	1.5 €/kg	Class 1 & 2 berry
	0.9 €/kg	Class 3 berry
Lettuce	0.4 €/kg	Summer
	0.2 €/kg	Winter
Cucumber	0.8 €/kg	Beginning of season
	0.3 €/kg	Mid-season wholesale

Table 1: Crop Pricing for GH 1

Buyers/markets

Bio Fruti has an offtake agreement with a wholesaler, Doni Fruits (https://www.donifruits.com/), which supplies local supermarkets. Doni Fruits requires a certain level of quality but the specifications of this was not explained. Bio Fruti reported that Doni Fruits will purchase much more of their produce if they can produce more. They estimated that they are only filling 5% of their order volume, so there is a great opportunity for expansion by this operation.

Profitability

Lettuce is considered to be the most profitable crop. Profitability of the greenhouse areas is €15 - €18,000 per year for the 5,000 M^2 or €3 - €3.6 per M^2 for covered areas.

Information on any financing previously sought / obtained

The first greenhouse was constructed in 2010 and has a 10 kWp solar (PV) installation and was financed by a cost-shared grant from the Ministry of Agriculture, Forestry and Rural Development (MAFRD). The total cost of both the greenhouse and 10 kWp solar installation was €32,000. The greenhouse portion was €22,000 (€22 per M^2). The Operator paid 50% and the MAFRD grant covered the other 50%. Subsequent greenhouses have been constructed for €15 per M^2.

GREENHOUSE # 2

Figure 3 Mr. Kastrati with just picked lettuce

Date of visit: March 5, 2019
Location: Peja

Ownership & management
This farm is owned and managed by Izet Kastrati. It is a family business. Mr. Kastrati is 60 years old and has a high school education with a focus on engineering. His company is called NTP Altina. In 2007 he began production with tunnels and in 2011 he began greenhouse production. This Operator expressed interest in both hydroponics and renewable energy technologies.

Type of structure
Arch style greenhouse with framing made of galvanized steel and PE plastic sheeting covering. One of his tunnels has double PE sheeting.

Size of structure
Mr. Kastrati owns 2 ha of land and leases 2 more. He has one greenhouse with 10 bays, which is 1,500 M^2 in size. He also has 2 tunnels, each 250 M^2, for lettuce production in winter and pepper/cucumber production in the summer.

Current heating systems and costs

There is no heat in the greenhouses or tunnels. A small portion of the greenhouse is used for seedling production and that area has extra cold protection and incandescent lights to provide heat for the seedlings.

For season extension, the tunnels have a double layer of PE sheeting. This provides extra insulation as a layer of warm air builds in the space between the layers of plastic. The double layers can be seen in the image above. Additionally, low tunnels are used inside the greenhouse to protect cucumbers during the early season.

Current irrigation / water systems and costs
Irrigation is done via drip irrigation. The cost to operate the irrigation pump is €80 per month during the main season May – September. During October – April, the cost averages €15 /monthly.

Labor model and structure
The operation uses family labor and then hires additional labor when needed.

Description of growing / cultivation methods
Vegetable crops (pepper, cucumber and lettuce) cultivated in soil in greenhouse and tunnels.

Pest issues and pest management
The main pest issue is spider mites on cucumbers. The Operator would like to install insect screening, but says that he cannot afford it.

Nutrient usage and management
Uses cattle manure from his cattle and dry fertilizer.

Wastage Amounts
Not tracked.

Crops produced & average prices

Pepper	1.5 €/kg	Beginning of season
	0.6 €/kg	Mid-season wholesale
Cucumber	1.0 €/kg	Beginning of season
	0.4 €/kg	Mid-season wholesale
Lettuce	0.42 €/ head	Average price

Table 2: Crop Pricing for GH 2

Buyers/markets
His brother is a wholesale buyer and he sells his product to him.

Profitability
The greenhouse/tunnels portion of the operation has an annual profit of approximately €12,000 per year. This translates to €6 per M^2. Lettuce is his most profitable crop.

Information on any financing previously sought / obtained

Construction of the greenhouse area of 1,500 M^2 cost €30,000 and was co-financed through a 50%:50% cost-shared grant from MAFRD. The total cost per M^2 was €20, with the cost to the operator being €10. A profit of €6 per M^2 means payback occurred at 1.67 years average for the greenhouse and tunnels.

Mr. Kastrati is interested in obtaining an additional grant to expand greenhouse production but there is a requirement to employ 3 people. He can't find enough labor and feels he will lose the grant because of this.

GREENHOUSE # 3

Figure 4: 4,500 M^2 greenhouse in Mamusha operated by Mr. Morina. A second cutting of spinach will be harvested and then tomatoes will be planted.

Date of visit: March 6, 2019
Location: Mamusha

Ownership & management
This farm is owned and managed by Nexhat Morina. Mr. Morina is 57 years old and has a high school education with a focus on economics. He is the president of the Mamusha Farmers Association. Mr. Morina has been farming all his life. He began tunnel production in 2011 and his greenhouse was constructed just last year (2018).

Type of structure

Arch style greenhouse with framing made of galvanized steel and PE plastic sheeting covering.

Size of structure
He has two greenhouses. The first one is 4,200 M^2 (0.42 ha) in size. The second greenhouse 2,500 M^2 in size. Mr. Morina invested extra funds to install thicker plastic on his greenhouse so that it will have a longer life span. He also has eight tunnels, each 250 M^2 for seedling and production of other crops.

Current heating systems and costs
There is no heat in the greenhouses or tunnels except for small electric heaters for seedlings. He would like to use a floating row cover to provide additional protection to seedlings (after transplanting) but it is too expensive.

Current irrigation / water systems and costs
Irrigation is done via sprinklers for spinach and drip irrigation for tomatoes and cucumbers. He has a 2.5 kWp solar installation that powers his irrigation pump which cost €4,000 (partially paid for through a grant from MAFRD).

Figure 5: This container doubles as a secure equipment storage location in addition to a platform for the solar panels.

Labor model and structure
Operation uses family labor and then hires additional labor when needed.

Description of growing / cultivation methods
Vegetable crops (spinach, cucumber, tomato) cultivated in soil in greenhouse and tunnels.

Pest issues and pest management

The main pest issue is Tuta Absoluta, a pest that can decimate tomato production[2]. This pest can spread rapidly in Mamusha due to the high concentration of tomato cultivation. He would like to have insect screening but says that he cannot afford it.

Nutrient usage and management
Uses cattle manure from his cattle and dry fertilizer.

Wastage Amounts
Not tracked.

Crops produced & average prices

Spinach	0.75 €/kg	Good season wholesale price
	0.20 €/kg	Bad season wholesale price
Cucumber-gherkins	0.3 €/kg	Wholesale average
	0.45 €/kg	Local average
Tomato	0.25-0.30 €/ kg	Average wholesale price

Table 3: Crop Pricing for GH 3

Buyers/markets
Spinach and tomatoes are sold in wholesale markets in Prishtina and Prizren. Gherkins are sold to a collection agency in Xerxe.[3]

Profitability (if this information is available)
Approximate profitability from the greenhouse area of 0.42 ha is around €16,000 or €4 per M^2 including two crops per year tomato and spinach.

Information on any financing previously sought / obtained (if this information is available)
The Greenhouse of 0.42 ha was financed through a cost-shared grant from MAFRD on a 65%:35% cost-shared basis (65% grant / 35% Operator contribution), with a total construction cost of €50,000 (greenhouse plus solar PV array). Because of the high value of this grant and lower investment from the farmer, his capital cost for the large greenhouse is approximately €3.5 per M^2. If his self-reported profitability of €4 per M^2 is accurate, then the payback period is estimated to be in one year.

[2] More information can be found here: http://www.inspection.gc.ca/plants/plant-pests-invasive-species/insects/tomato-leafminer/fact-sheet/eng/1328634442933/1328887251933

[3] There are six collection agencies in Kosovo. In some cases they were set up to with foreign aid.

GREENHOUSE # 4

Figure 6: Mamusha greenhouse getting prepared for spring planting.

Date of visit: 3/7/19
Location: Mamusha

Ownership & management
This farm is owned and managed by Rexhep Kryezi. His business is called NTP "Sibel". Mr. Kryezi is 55 years old and has an elementary school education. He grew up farming and constructed his first greenhouse in 2015. The second greenhouse, pictured above, was constructed in 2018.

Type of structure
Arch style greenhouse with framing made of galvanized steel and PE plastic sheeting covering.

Size of structure
Mr. Kryezi has 3 ha of total farm area of which 2 ha are under greenhouse or tunnel production. The greenhouse that we visited (pictured above) is a multi-span greenhouse with 8 bays measuring 2,400 M^2.

Current heating systems and costs
There are small heating units in the tunnels used for seedling production and insulation around some of the perimeter of the tunnel used for seedling production (Figure 7). Additionally, he has a plastic sub-roof in his greenhouse for retaining heat.

Figure 7: Drum stove heating system to heat tunnel for seedling production shown at left. Insulation for lower portion of tunnel walls shown at right.

Current irrigation / water systems and costs
Irrigation is done via drip irrigation. To operate the irrigation pump, the cost is €80 per month during the main season May – September. During October – April, the cost averages €15 monthly.

Labor model and structure
The operation uses 8 family members working full time, plus 1 full time employee.

Description of growing / cultivation methods
Vegetable crops (tomato, cucumber, spinach) cultivated in soil in greenhouse and tunnels.

Pest issues and pest management
The main problem is Tuta Absoluta. He has reduced pressure from Tuta because he is on the outskirts of Mamusha, away from many other Operators. He manages Tuta using an insecticide that comes from Turkey. He would like to have insect netting, but says he can't afford it. He also notes problems with thrips and spider mites.

Nutrient usage and management
Uses cattle manure from his cattle and dry fertilizer.

Wastage Amounts
Not tracked.

Crops produced & average prices

Tomato	0.5-0.6 €/kg	Average price
Cucumber (gherkin)	0.6 €/kg	Beginning of season
	0.3 €/kg	Mid-season wholesale
Spinach	1.0 €/kg	Good season wholesale price
	0.20 €/kg	Bad season wholesale price

Table 4: Crop Pricing for GH 4

Buyers/markets
Produce is sold to wholesale buyers in Mitrovica and Gjilan.

Profitability (if this information is available)
Mr. Kryezi says that he has a profit of approximately €25,000 per ha of greenhouse production, or €2.5 profit per M^2.

Information on any financing previously sought / obtained (if this information is available)
The 5,000 M^2 greenhouse was funded through a 65%:35% cost-shared grant from MAFRD in 2015. The total cost of the greenhouse was €94,000. The grant covered 65% of this cost and the Operator paid 35%. This means that the cost per M^2 for the operator was €6.58. Based on the profitability reported by the Operator, the payback period for this greenhouse would be about 2.6 years.

GREENHOUSE # 5

Figure 8: Seedling production Mr. Duraku's greenhouse. Seedlings on the left are covered to protect from the cold at nights.

Date of visit: March 8, 2019
Location: Krusha e madhe/Rahovec

Ownership & management
This farm is owned and operated by Mr. Ekrem Duraku. He began farming with tunnels in 1996 and built his first greenhouse in 2001. The most recent greenhouse was constructed in 2018.

Type of structure
Arch style greenhouse with framing made of galvanized steel and PE plastic sheeting covering.

Size of structure
Mr. Duraku has 3,000 M^2 under cover. This consists of mostly small tunnels and two small greenhouses (one measures 1,000 M^2 and the other 500 M^2). The total area farmed is 4 ha. Of this land, he owns 3 ha and 1 ha is leased.

Current heating systems and costs
There is no heating in the greenhouses. The Operator uses styrofoam panels underneath seedlings and plastic/row covers when possible to help protect seedlings. He would like to have heating mats for seedling production but says that he can't afford it.

Current irrigation / water systems and costs
This Operator uses two types of water. For seedlings, he uses well water since the chlorine levels in the municipal water were too high for seedlings. The cost to operate the pump does not exceed €20 per month. After transplanting to the greenhouse or open field, the Operator uses municipal water at a cost of €130 per ha per year. Irrigation is done via sprinklers for lettuce and spinach and drip for peppers and cucumber crops.

Labor model and structure
He has 6 family members that help with the farm operation. He will hire 2-3 workers, as needed, for transplanting and harvesting.

Description of growing / cultivation methods
Vegetable crops (spinach, lettuce, cucumbers and peppers) cultivated in soil in greenhouse and tunnels.

Pest issues and pest management
Thrips on cucumbers and rodents are the main issues he faces. He uses insecticides to manage thrips and a combination of rodent poison and sound producing stakes to deter rodents.

Nutrient usage and management
Uses cattle manure from his cattle and dry fertilizer.

Wastage Amounts
Not tracked.

Crops produced & average prices

Spinach	0.4 €/kg	Average wholesale price
Lettuce	0.2-0.25 €/head	Average wholesale price
Cucumbers	0.25 €/kg	Average wholesale price (seasonal variation of 0.1 - 0.4 €/kg)
Peppers		Not reported

Table 5: Crop Pricing for GH 5

Buyers/markets
This producer sells to wholesale buyers in addition to store owners that come to visit his farm and purchase directly from him. He mentioned that he could use help in promoting his products and finding new buyers.

Profitability (if this information is available)
The net profit for the entire operation is approximately €20,000 per year. This translates to a profit of approximately €5,000 per ha or €0.5 per M^2. These levels are much lower than those reported at other similarly sized farms. It is unclear how the profitability of the greenhouse areas compares with the profitability of the open field areas.

Information on any financing previously sought / obtained (if this information is available)

The two greenhouses have been financed through cost-shared grants. The 1,000 M^2 greenhouse was through a MAFRD grant on a 50%:50% cost share basis. The total cost of the greenhouse was €20,000. The 500 M^2 grant was financed through a municipal grant. The municipality covered 80% of the cost and the Operator 20%. He expressed interest in replacing his existing tunnels with a large, modern greenhouse with automated ventilation in the future.

GREENHOUSE # 6

Figure 9: Armend Krasniqi's greenhouse for production of plant starts and ornamental plants.

Date of visit: March 9, 2019
Location: Studenqan/Suharek

Ownership & management
This business is owned and operated by Mr. Armend Krasniqi. He operates the business with his family members. Mr. Krasniqi is 34 years old and has a Master's Degree in agriculture with a focus on viticulture and fruit production. He also works as an agricultural consultant. He began farming in 2000 and began tunnel production in 2001. His greenhouse was built in 2018. This operation is unique because Mr. Krasniqi mainly sells ornamental plants and vegetable starts to home gardeners. He does a small amount of cucumber and lettuce production, but plant starts are his main focus.

Type of structure
Arch style greenhouse with framing made of galvanized steel and PE plastic sheeting covering.

Size of structure
Mr. Krasniqi has a small 350 M^2 greenhouse. The total area farmed is 1 ha (10,000 M^2).

Current heating systems and costs
There is a small electric heater to protect seedlings on very cold nights. This is the only heating. He would like to have elevated benches and a heating system (radiant heat) for improved seedling production.

Current irrigation / water systems and costs
This Operator uses municipal water, which is high quality spring water (due to location at the base of mountains). Water costs €10-15 per month. Plant starts are watered by hand with a hose, lettuce with a sprinkler and cucumbers with drip irrigation.

Labor model and structure
Has 3 family members that help with the farm operation. He hires additional help for the transplant season.

Description of growing / cultivation methods
Seedlings and plant starts grown in flats and pots. Vegetable crops cultivated in soil in greenhouse.

Pest issues and pest management
None.

Nutrient usage and management
Purchases cattle manure and tills into soil.

Wastage Amounts
Not tracked.

Crops produced & average prices

Plant starts	0.25 €/each	Price to home gardeners
Lettuce	0.3 €/ head	Price to local buyers
Cucumbers	0.70 €/kg	Price to local buyers

Table 6: Crop Pricing for GH 6

Buyers/markets
This producer sells to local gardeners and town residents.

Profitability (if this information is available)
The net profit for the entire operation is approximately €5,000 per year. This translates to a profit of approximately €0.5 per M^2 over the total production space. Plant starts are his most profitable crop, followed by cucumbers and lettuce. It is unclear what percentage of revenues are from the outdoor and greenhouse portions of the farm, but it is assumed that the profitability for the greenhouse portions are much higher than the outdoor portion (per M^2).

Information on any financing previously sought / obtained (if this information is available)

The greenhouse was financed through a cost-shared grant from the Austrian Development Agency. The 350 M^2 greenhouse cost €17 per M^2 with a cost share of 80%:20% (80% grant and 20% cost share from the Operator). The operator paid €3.4 per M^2.

Figure 10: Sticker on the outside of Mr. Krasniqui's greenhouse

GREENHOUSE # 7

Figure 11: Mr. Morina and his lettuce crop.

Date of visit: March 9, 2019
Location: Reshtan/Suharek

Ownership & management
This business is owned and operated by Mr. Nesim Morina. He operates the business with his wife. Mr. Morina is 54 years old and has a master's degree in agriculture with a focus on viticulture. He works in the MAFRD Wine Institute. He has been farming all his life, but began greenhouse production in 2013.

Type of structure
Arch style greenhouse with framing made of galvanized steel and PE plastic sheeting covering.

Size of structure
Mr. Morina has two greenhouses, each 1,000 M^2. Additionally, he operates 5,000 M^2 of field production. The total area farmed is 0.7 ha (7,000 M^2).

Current heating systems and costs
Mr. Morina uses incandescent light bulbs to provide heat for seedlings.

Current irrigation / water systems and costs
He originally used a well at the front of his property, but the salinity level was very high. Later he dug another well behind his greenhouses and the water quality is much better. The cost to operate pump is approximately €25-30 per month. He uses drip irrigation for all his crops.

Labor model and structure
Mr. Morina's wife helps with the operation and he hires some women from the local community to help with harvesting and sales.

Description of growing / cultivation methods
Vegetable crops cultivated in soil in greenhouse. Mr. Morina expressed a strong interest in using hydroponic production systems for strawberry production.

Pest issues and pest management
Main pest problems are spider mites, aphids and phytophthora. Mr. Morina is the first farmer that is using sticky traps to monitor greenhouse pests. He does not have insect screening but is aware that he should. Cost is the major issue. He says that when he first began greenhouse production, pests weren't a problem but now they are.

Nutrient usage and management
Purchases pelleted chicken manure from Italy (Italpollina 4:4:4+70.7 OM - https://italpollina.com) and applies it at a rate of 120 kg per 1,000 M^2.

Wastage Amounts
Not tracked.

Crops produced & average prices

Strawberries	1.5 €/kg	Price to local residents
Lettuce	0.22 €/ head	Wholesale price

Tomatoes	First year of production- prices not available yet	Will sell to same buyer as lettuce.

Table 7: Crop Pricing for GH 7

Buyers/markets

This producer sells strawberries to local residents and sells lettuce wholesale. Tomato sales were not reported.

Profitability (if this information is available)

The net profit for the entire operation is approximately €6,000 per year. This is based on €10,000 revenue and €4,000 expenses per year. This translates to a profit of approximately €0.85 per M^2.

Information on any financing previously sought / obtained (if this information is available)

The greenhouse was financed through a cost-shared MAFRD grant (40%:60%). The total cost for the greenhouses was €40,000. The Operator was responsible for 40%, so had a cost of €16,000 or €8 per M^2.

GREENHOUSE # 8

Figure 12: Mr. Kuqi's greenhouse, which hasn't been active for several months.

Date of visit: March 9, 2019
Location: Suharek

Ownership & management
This greenhouse is operated for home consumption by Ylber Kuqi. When we visited this greenhouse, it was damaged and overgrown with weeds. It is assumed that in the spring it will be cleaned and planted for home consumption. The Operator works in the MAFRD Wine Institute. He is 49 years old and has an agriculture degree. The greenhouse was constructed in 2016.

Type of structure
Arch style greenhouse with framing made of galvanized steel and PE plastic sheeting covering.

Size of structure
The small greenhouse is 200 M^2. Mr. Kuqi also farmed 2,100 M^2 of raspberries on the surrounding land, but this crop had been abandoned due to a price drop for berries, removing its economic viability.

Current heating systems and costs
There is no heating present.

Current irrigation / water systems and costs
This Operator uses a well. Cost to operate pump for irrigation does not exceed €10 per month.

Labor model and structure
N/A

Description of growing / cultivation methods
In ground cultivation.

Pest issues and pest management
Unknown

Nutrient usage and management
Unknown

Wastage Amounts
Unknown

Crops produced & average prices
N/A

Buyers/markets
N/A

Profitability (if this information is available)
N/A

Information on any financing previously sought / obtained (if this information is available)
The greenhouse was financed through a 75%:25% cost-shared grant (the grant covered 75% and the Operator paid 25%) from the Initiative for Agricultural Development of Kosovo (IADK). The total cost of the greenhouse was €3,800, or €19 per M^2. The Operator's share was €950, or €4.75 per M^2.

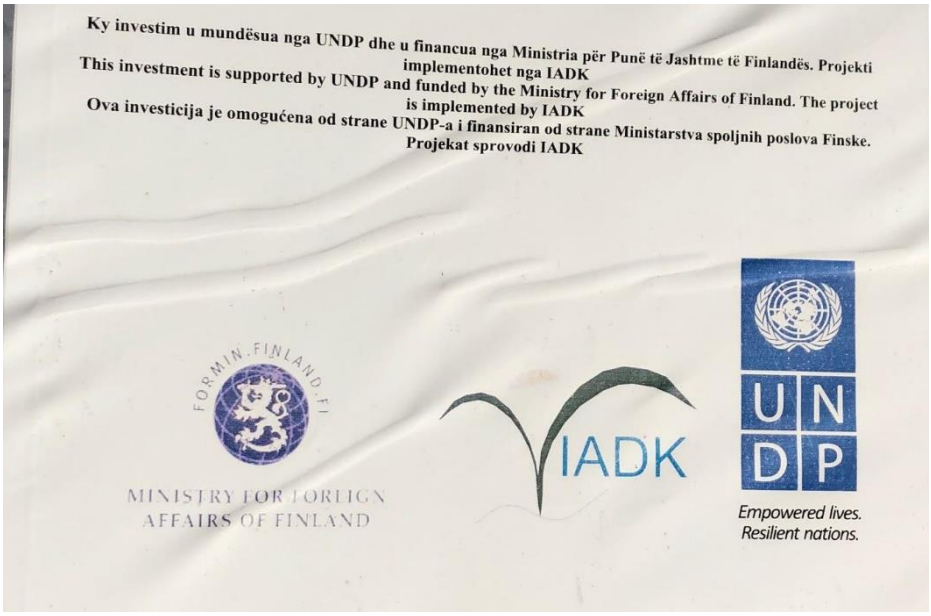

Figure 13: Sticker on the outside of Mr. Kuqi's greenhouse.

GREENHOUSE # 9

Figure 14: Spinach ready for harvest in Mr. Duraku's greenhouse.

Date of visit: 3/11/19
Location: Krusha e madhe/Rahovec

Ownership & management
This farm of 13 ha is owned and managed by Ismajl Duraku. Mr. Duraku is 47 years old and has been farming all his life. He has a university degree in finance. His children are studying economics and agriculture at the university but he fears that they will want to live abroad and won't be interested in continuing his farm.

Type of structure
Arch style greenhouse with framing made of galvanized steel and PE plastic sheeting covering.

Size of structure
Mr. Duraku has one small greenhouse (700 M^2) for crop production and 2 small tunnels (150 M^2 each) for seedling production. He began farming with tunnels in 2004 and added the greenhouse in 2014. In 2008, he was recognized as the best farmer in Kosovo and his produce is global gap certified. He would like to expand greenhouse production by constructing a 3,500 M^2, high tech structure with automated ventilation, etc. He believes that he will not be eligible for a grant since he is over 45 years old and he doesn't operate in a rural area. Still, he believes it will be a good investment, even without a grant.

Current heating systems and costs
There is no heating present.

Current irrigation / water systems and costs
Irrigation is done via sprinkler for spinach and drip irrigation for tomatoes, peppers and cucumbers. He uses municipal water from Radoniqi at a cost of €10 per month per ha. He also has a well to supplement greenhouse irrigation. He collects rainwater from his greenhouse and redirects this water into well.

Labor model and structure
The operation uses 27 family members plus 3-4 seasonal employees as needed.

Description of growing / cultivation methods
Vegetable crops (tomato, cucumber, spinach, pepper) cultivated in soil in greenhouse. Seedlings cultivated in tunnels.

Pest issues and pest management
Spider mites on cucumber is the main problem in greenhouse production. He does not have insect screening but would like to invest in it. He is worried about anthracnose in open field pepper production and thinks greenhouse production would be favorable for disease management.

Nutrient usage and management
Uses 10 tons of chicken manure per ha and dry fertilizer.

Wastage Amounts
Not tracked.

Crops produced & average prices

Tomato	0.3- 0.35 €/kg	Direct to consumer price
Cucumber (gherkin)	0.25-0.3 €/kg	Direct to consumer price
Pepper	0.3- 0.35 €/kg	Direct to consumer price
Spinach	0.5- 0.6 €/kg	Direct to consumer price

Table 8: Crop Pricing for GH 9

Buyers/markets

Produce from open field production is sold wholesale to Elkos. Produce from greenhouse production is sold direct to consumer in his retail store. He also processes different crops (pickles, etc.) and sells in his store.

Profitability (if this information is available)

The Operator did not give specific information on the profitability of his operation but stated that the greenhouse portion is profitable and he would like to increase greenhouse production. He did state that tomatoes are his most profitable crop followed by peppers, cucumbers and spinach.

Information on any financing previously sought / obtained (if this information is available)

The greenhouse was financed by an international NGO through a project implemented by the collection center Agrocelina with 75%:25% cost share (75% grant with 25% paid by the Operator). The total cost was €14,000 for area of 700 M^2 or €20 per M^2. His portion was €3,500 or €5 per M^2.

Figure 15: Pickled items for sale at Mr. Duraku's store.

GREENHOUSE # 10

Figure 16: Mr. Shala and Ismet Babaj look at Batavia lettuce almost ready for harvest.

Date of visit: 3/12/19
Location: Qyshk/Peja

Ownership & management
This farm is owned and managed by Selmon Shala. Mr. Shala is 51 years old and has a finance degree. He has been farming all his life. He began farming with tunnels in 2001 and with greenhouse production in 2008. This appeared to be the most sophisticated operation that the team visited.

Type of structure
Arch style greenhouse with framing made of galvanized steel and PE plastic sheeting covering.

Size of structure
Mr. Shala farms 10 ha in total. He has numerous greenhouses totaling 1.2 ha and 0.08 ha of tunnels. He would like to construct one more greenhouse and improve the level of technology in existing greenhouses.

Current heating systems and costs

One of Mr. Shala's greenhouses contains a heating system which cost €8,000. This system burns coal to heat water for a radiant heating system. He attempted to use the system, but it was too expensive to operate. Instead, he has opted for a second layer of plastic inside greenhouses to trap heat. The exterior plastic is 150 microns while the internal layer is 50 microns thick. This sub-roof can be removed as necessary when the temperature is too warm.

Figure 17: The internal plastic layer, which is used for heat retention can be seen here.

Solar Panel System

Figure 18: Solar Panel systems at GH 10

The solar panel system used by this Operator consists of a polycrystalline PV module and inverter charger. More information is presented below in Figures 19-21. The cost of the system was around €4,000. 60% of the costs were paid by the Ministry of Agriculture. The operator paid the remaining 40%.

Figure 19: Effekta AX-Series PV Inverter

Figure 20: Inverter Charger

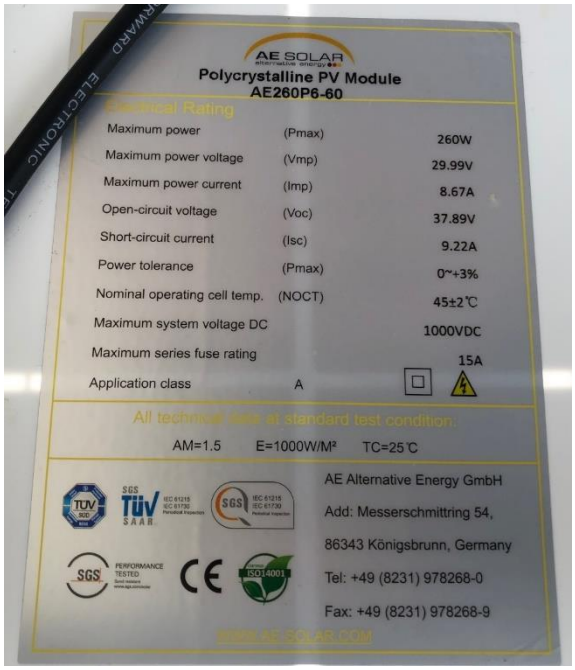

Figure 21: Data Sheet on PV Module

Current irrigation / water systems and costs
Irrigation is done via drip irrigation. Pumps to irrigate are powered by the grid in all greenhouses except one which is connected to a solar panel system (Figure 18). The cost of operating the grid operated pumps varies from €70- €100 per month.

Labor model and structure
The operation has 3 permanent employees. These 3 employees have been working with him for more than 3 years and 1 employee for more than 10 years.

Description of growing / cultivation methods
Vegetable crops cultivated in soil in greenhouse and tunnels.

Pest issues and pest management
The main pest problems are aphids and spider mites (cucumbers), Tuta Absoluta (tomatoes) and occasionally botrytis (lettuce). He does not spray his lettuce and tells his buyers that it is better to rinse off aphids than to consume pesticides. Mr. Shala says that there is a growing consciousness among consumers for higher quality and chemical free produce. He doesn't use insect netting, due to the cost.

Nutrient usage and management
Uses cattle manure and minimal amounts of dry fertilizer.

Wastage Amounts
Not tracked.

Crops produced & average prices

Tomato	0.3€/kg	Wholesale price
Cucumber (gherkin)	0.2 €/kg	Wholesale price
Pepper	0.85 €/kg	Wholesale price
Lettuce	0.25 €/head	Wholesale price

Table 9: Crop Pricing for GH 10

Buyers/markets
Produce is sold to wholesale buyers for the supermarkets in Peja but he thinks that he can also supply buyers serving Pristina.

Profitability (if this information is available)
Mr. Shala says that tomatoes are his most profitable crop followed by lettuce. Greenhouse production is 2x as profitable as field production because of more production cycles and better quality of produce. He has a total annual profit of €50-60,000 on 10 ha or €5-6,000 per ha. This translates to a profit of €0.5-0.6 per M^2.

Information on any financing previously sought / obtained (if this information is available)
One of the greenhouses was financed through a 55%:45% cost-shared grant (55% grant and 45% Operator contribution) from MAFRD at a total cost of as €64,000.

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