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ECONOMICS OF HIGH-TUNNEL VEGETABLE PRODUCTION IN IRAQ

November 15, 2010

This publication was produced for review by the United Satets Agency for International Development. It was prepared by Franco Scotti, Competitiveness Manager for *Inma* Agribusiness program a consortium led by the The Louis Berger Group, Inc.

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Executive Summary

Since 2008, the United States Agency for International Development-funded Inma Agribusiness Development Program has been implementing a vegetable production training and demonstration activity. This includes demonstration of "High-Tunnel" greenhouse production in Central Iraq. Using a database assembled from detailed records of the operations of these demonstration greenhouses and price information from the Inma-supported Agricultural Market Information System, Inma carried out for the first time an analysis of the economics of high-tunnel vegetable production under current Iraqi conditions. The present report projects profitability and growth potential for four of the most popular vegetables consumed in Iraq: tomatoes, cucumbers, eggplants, and okra.

Analysis findings indicate that vegetable production for out-of-season markets under high tunnel greenhouses can be quite competitive with imports. High tunnel production is profitable and financially sustainable for the producer who adopts modern greenhouse production technologies, management practices and marketing strategies. One full-time operator should be able to effectively manage at least 5 high-tunnel greenhouse units of $500M^2$ each (3 units for okra). A well-managed enterprise with this production capacity can be expected to generate annual enterprise profit levels that range from a low of $4,000 for eggplants to a high of $7,000 for okra. As experience is gained, a full-time owner-operator can be expected to effectively manage up to 10 greenhouses.

There is considerable opportunity for continued expansion of high tunnel production to meet Iraqi consumer demand. Based on projections of demographics and incomes, evolving food consumption patterns and competition levels from imports, Inma estimates that for the four vegetables analyzed, the number of high tunnel units in central and southern Iraq, can increase from the current 10,000 units to 25,000 units without danger of consumer market saturation. And an additional 9,000 units can be added in Northern Iraq without danger of severe negative price impacts. Diversifying into vegetables other than cucumbers and tomatoes can further increase growth potential for high-tunnel systems of production. Nevertheless, the increase in numbers of high tunnel units should be closely monitored to avoid future over-supply conditions and excessive price deterioration.

Background and Setting

During the 1980's, Iraq was self-sufficient in vegetable production and exported fresh produce regionally. Subsequently, misguided policies and multiple armed conflicts combined to severely disrupt the Iraqi fresh produce value chain. Irrigation systems and other physical infrastructure were damaged or fell into disrepair, while economic uncertainty and security concerns loomed. Improved seeds and other modern production inputs were no longer available, and producers were cut off from worldwide advances in production and marketing technologies. Many vegetable producers abandoned their farms and others reverted to low-input, low-yield and low-profitability production practices.

Imports increased rapidly to offset declines in domestic production. By 2007, two-thirds of fresh vegetable consumption in Iraq was imported. As political and economic conditions improve, urban consumers demand more fresh produce. But for several reasons, Iraqi producers have had difficulty in competing with imports in the Iraqi consumer marketplace.

Inma value chain studies in 2007-2008 identified several constraints to competitiveness by Iraqi vegetable producers: Lack of access to improved seed and planting materials, lack of knowledge about modern production technologies.These practices result in low yields, high production costs and low-quality produce. Additionally, in the absence of market intelligence, most producers tend to plant at the same time resulting in market saturation and low prices at harvest. At other times, supplies of national production are limited, and the consumer market depends on imports.

Iraqi consumers prefer vegetables produced in Iraq, at times paying up to 30-35% more for comparable quality Iraqi produce. Recent data collected by the Inma Horticulture Team suggests that consumers tend to switch to imported produce in the presence of a 15% price difference. This preference can help Iraqi producers to be competitive with foreign producers who often benefit from subsidized prices for energy and other production inputs. To assist Iraqi vegetable producers to become more efficient and competitive, the USAID-funded Inma Agribusiness Development Program was designed and launched in the spring of 2008, with a vegetable production training and demonstration activity. This activity targeted both open field production and greenhouse production.[1] For the latter, Inma provided financial and technical assistance to establish six demonstration high-tunnel greenhouses[2] in central Iraq. These demonstration greenhouses provide protection from weather inclemency sufficient to permit production for out-of-season markets (November to May). Intensive training has been provided in modern greenhouse production methods and practices.[3]

For the demonstration greenhouses, detailed records have been kept about production practices, yields and costs of production. For the first time, data from these records and Iraqi market price data[4] have been used to measure profitability of high-tunnel greenhouse

[1] For example, for open field production, "low-tunnel" plastic coverings were introduced to permit earlier spring plantings that reach markets before prices drop from over-supply.

[2] High-tunnel greenhouses are plastic-covered structures (heated or unheated) that provide an intermediate level of environmental protection compared to open field conditions on the one hand, and fully climate-controlled greenhouses, on the other. High-tunnels are tall enough to stand and walk in comfortably, and to grow trellised crops such as tomatoes. Although high tunnels are available in several sizes, the most common size in Iraq is $500M^2$.

[3] High-tunnel greenhouses have been imported into Iraq in significant numbers since 2006. By 2008, Inma estimated that approximately 5,000 units were in use, but many of these were using outdated production and management practices.

[4] Farm gate and wholesale market prices collected by the Inma-supported ANKA Company Agricultural Market Information System (AAMIS).

production enterprises under current Iraqi conditions. This report also includes a preliminary estimate of the limits to growth for out-of-season production.

Costs and Returns

Costs and returns for high-tunnel greenhouse operations involve three performance variables: Costs of Production, Market Prices, and Yields. Analysis results for each of these variables are described below.

Costs of Production: Table 1 (below) presents annual costs of production (two crop cycles) in a single greenhouse for four different vegetables.[5] These costs are based on actual records from the demonstration greenhouses. The ten categories of variable costs presented in Table 1 represent expenditures required only as production occurs.

Fixed costs are longer term investments with a useful life beyond one year. These costs are incurred whether or not production occurs. Fixed cost items for each greenhouse operation are: 1) a 500m^2 high-tunnel greenhouse ($3,000 amortized over 5 years), 2) a drip irrigation system ($520 amortized over 4 years), and, 3) a space heater unit ($1,000 amortized over 10 years).[6]

Table 1: Estimated Annual Costs of Production ***(Two Crop Cycles) in One High-Tunnel Greenhouse of 500M², for Four Vegetable Crops.***
(Based on Data from Inma-Supported Demonstration Greenhouses located in Central Iraq)

Annual Costs of Production (Two Crop Cycles in $US)	Tomatoes	Cucumbers	Eggplants	Okra
Seeds	290	400	290	40
Transplants	30	30	30	15
Fungicides and Insecticides	64	64	64	50
Fertilizers	60	60	60	95
Electricity	40	40	40	80
Packaging	36	36	36	72
Land Preparation	32	32	32	55
Harvesting	70	70	70	280
Other Labor	50	50	50	200
Heating	360	360	360	560
Subtotal Variable Costs	1,032	1,142	1,032	1,447
Greenhouse 500m2 ($3,000 investment, amortized in 5 yrs)	600	600	600	600
Irrigation System ($520 investment, amortized in 4 yrs)	130	130	130	130
Space Heater ($1,000 investment, amortized in 10 yrs)	100	100	100	100
Row covers and Plastic Mulch	0	0	0	670
Subtotal Fixed Costs	830	830	830	1,500
Total Variable and Fixed Costs	1,862	1,972	1,862	2,947
Financial Expenses	60	60	60	120

Generated by: Inma Horticultural Team, January, 2010

[5] The four vegetables are: tomatoes, cucumbers, eggplants and okra. These are the four most popular vegetables among Iraqi consumers.

[6] Thus, annual costs are: 1) $600, 2) $130, and, 3) $100, respectively, and are the same regardless of the crop.

For purposes of this analysis, the greenhouse enterprise is owner-operated. The owner-operator provides his own labor for management and operations and uses only limited outside labor, primarily during planting and harvest. The owner-operator labor input into the enterprise is not included as a cost of production, but rather is treated as a "factor of production", remunerated only if there are profits (a positive cash flow). It also is assumed that a typical greenhouse enterprise of a full-time owner-operator consists of five (5) high-tunnel greenhouses of 500M^2, each (1/4 hectare under cover).[7] With additional experience, a full-time owner-operator enterprise can be expected to increase the size of operations to as many as ten (10) greenhouses of 500M^2 each (i.e., ½ hectare under cover). This is the amount currently handled by one person in Turkey.[8]

As shown in *Table 1*, production costs for tomatoes, cucumbers and eggplants are similar. Okra costs of production are much higher, offset, by continuous harvest from one planting.[9]

Market Prices**:** The Inma profitability analysis applied a price probability model based on 2009 prices (adjusted for seasonality using a longer time series from 2005 through 2009). The resulting prices (shown in Table 2, below), represent the most likely prices to occur in the market in 2010, for the season indicated.

Table 2: Vegetable Prices *(ID/kg) at the Farm Gate and in Wholesale Markets Projected for 2010, by Crop and "High-Price" Season*
Source: Inma Seasonality Study for Horticultural Products, ANKA Wholesale prices

	Farm Gate		Wholesale	
Price ID/kg	Winter	Early Spring	Winter	Early Spring
Tomato	396	326	582	480
Cucumber	421	245	585	340
Eggplant	418	410	580	570
Okra	2,170	2,170	2,713	2,713

Of the four crops analyzed, tomatoes show a consistently high "coefficient of variation" (28%) for wholesale prices, as compared to cucumbers, eggplants and okra. The coefficient of variation is the probability of deviation from average prices. For tomatoes, this may be considerable, i.e., ± 28% in any particular crop season. Thus, tomato producers face much higher risks of wide price fluctuations than do producers of the other three vegetable crops. Cucumbers, Eggplants and Okra have relatively low variations in prices (14%, 12%, and 8%, respectively) meaning a greater probability that prices will stay within the price band indicated by the Inma probability model used to develop Table 2.

Yields**:** A range of yields are used to calculate gross sales income (total returns) at different yield performance levels (See Tables 3, 4, 5 and 6, below). A range of five possible yield levels is used, with one intermediate yield designated as the "targeted" yield. The targeted yields selected were estimated by the Inma Horticulture Team as the most likely

[7] Because of added operating and management inputs required under the "double-harvest" system for Okra, a full-time Okra producer is targeted to handle 3 units, instead of 5.
[8] For enterprises producing Okra, the number of greenhouses handled is expected to increase over time from 3 up to 6.
[9] For Okra, the production system of continuous cut-back after the initial harvest permits subsequent continuous harvesting from re-growth (called the "ratoon" crop).

yields to be achieved by owner-operators who adopt Inma-recommended production and management practices.

Cash Flow and Profitability

Based on the performance variables described in the previous section, annual cash flows are projected for each of the four vegetable crops in Tables 3, 4, 5 and 6, below. These projections are based on two crop cycles annually in a single greenhouse. Five different yield scenarios are shown for each.

Tomatoes: At the targeted yield of 100MT/ha, the projected annual positive cash flow for tomatoes are $1,087 (two crop cycles) for a single greenhouse (see Table 3, below). The "break-even" point is around 65MT/ha. This is the point at which gross income from sales (total returns) just covers costs, with no compensation in the form of profits (i.e., no positive cash flow) to the owner-operator for his management and operating labor. Returns below break-even would result in gradual de-capitalization of the enterprise. A full-time owner/operator with an enterprise of 5 greenhouses achieving targeted yields would earn an annual profit (positive cash flow) of $5,435 (assuming the enterprise marketing strategy achieves the sales price used here).

Table 3: Estimated Annual Profitability of Tomatoes in Central and Southern Iraq *(Two Crop Cycles in One High-Tunnel Greenhouse of 500M²)*

TOMATOES	Central and Southern Iraq				
Yields (Tons/ha)	70	80	90	100	110
Yields/Greenhouse 500m²	7	8	9	10	11
Price- Wholesale (ID/kg)	531	531	531	531	531
Net Return (ID/kg)	361	361	361	361	361
Total Return ($)	2,106	2,407	2,708	3,009	3,310
Total Cost	1,922	1,922	1,922	1,922	2,010
Cash Flow	184	485	786	1,087	1,300
Cash Flow as % of Total Return	8.70%	20.20%	29.00%	36.10%	39.30%
Total Cost ($/kg)	0.275	0.24	0.214	0.192	0.183

Source: Anka Wholesale Prices 2009, Inma Seasonality Study for Horticultural Produces

Cucumbers: At the targeted yield of 110MT/ha, cucumbers earn an annual Positive Cash Flow of $1,021 (two crop cycles) for a single greenhouse (see Table 4, below). This level of profitability is similar to tomatoes, but with lower risk of wide price variations. The break-even point occurs at around 80MT/ha. A full-time owner/operator handling a 5 greenhouse enterprise that achieves targeted yields can expect an annual profit level of $5,105.

Table 4: Estimated Annual Profitability of Cucumbers *in Central and Southern Iraq (Two Crop Cycles in One High-Tunnel Greenhouse of 500M²)*

CUCUMBERS	Central and Southern Iraq				
Yields (Tons/ha)	80	90	100	110	120
Yields/Greenhouse 500m²	8	9	10	11	12
Price Wholesale (ID/kg)	463	463	463	463	463
Net Return (ID/kg)	333	333	333	333	333
Total Return ($)	2,220	2,498	2,775	3,053	3,330
Total Cost	2,032	2,032	2,032	2,032	2,032
Cash Flow Margin	188	466	743	1,021	1,298
Cash flow as % of Total Return	8.50%	18.60%	26.80%	33.40%	39.00%
Total Cost ($/kg)	0.254	0.226	0.203	0.185	0.169

Source: Anka Wholesale Prices 2009, Inma Seasonality Study for Horticultural Produces

Eggplants: Eggplants, at the targeted yield of 80MT/ha, provide an annual Positive Cash Flow of $838, based on two crop cycles in one greenhouse (see Table 5, below).. This is a lower cash flow than for tomatoes but, as discussed earlier, with much less risk of wide price fluctuations. The break-even point occurs at around 60MT/ha. An owner/operator handling a 5 greenhouse enterprise that achieves targeted yields would earn profits of $4,190 annually.

Table 5: Estimated Annual Profitability of Eggplants *in Central and Southern Iraq (two Crop Cycles in one High-Tunnel Greenhouse of 500M²)*

EGGPLANTS	Central and Southern Iraq				
Yields (Tons/ha)	50	60	70	80	90
Yields/Greenhouse 500m²	5	6	7	8	9
Price Wholesale (ID/kg)	575	575	575	575	575
Net Return (ID/kg)	414	414	414	414	414
Total Return ($)	1,725	2,070	2,415	2,760	3,105
Total Cost	1,922	1,922	1,922	1,922	1,956
Cash Flow Margin	-197	148	493	838	1,149
Cash Flow Margin as % of Total Return	-11.40%	7.10%	20.40%	30.40%	37.00%
Total Cost ($/kg)	0.384	0.32	0.275	0.24	0.217

Source: Anka Wholesale Prices 2009, Inma Seasonality Study for Horticultural Produces

Okra: Using "double-crop" practices, okra profitability amply outperforms tomatoes, cucumbers, and eggplants. The break-even point for Okra occurs at about 9MT/ha. At the targeted yields of 15MT/ha, okra provides an annual Positive Cash Flow of $2,398 for one greenhouse, which is a profit level for a 3 greenhouse enterprise of $7,194.

Table 6: Estimated Annual Profitability of Okra *in Central and Southern Iraq (One Double-Harvest Cycle in one High-Tunnel Greenhouse of 500M²)*

OKRA	Central and Southern Iraq				
Yields (Tons/ha)	10	12	15	17	20
Yields/Greenhouse 500m²	2	2.4	3	3.4	4
Price Wholesale (ID/kg)	2,713	2,713	2,713	2,713	2,713
Net Return (ID/kg)	2,170	2,170	2,170	2,170	2,170
Total Return ($)	3,617	4,340	5,425	6,148	7,233
Total Cost	3,027	3,027	3,027	3,027	3,027
Cash flow Margin	590	1,313	2,398	3,121	4,206
Cash Flow Margin as % of Total Return	16.30%	30.30%	44.20%	50.80%	58.20%
Total Cost ($/kg)	1.514	1.261	1.009	0.89	0.757

Source: Anka Wholesale Prices 2009, Inma Seasonality Study for Horticultural Produces

Enterprise Profit Levels

Profit levels presented in Tables 3, 4, 5 and 6 in the previous section are for one year of operations (two crop cycles) for a single greenhouse. Each greenhouse operation produces two harvests for the out-of-season markets, i.e., winter and early spring markets. In the case of Okra, there is a continuous harvest from one planting (a main harvest and subsequent "ratoon" harvesting as old growth is cut back). The first three columns of Table 7, below, summarize these annualized results for one greenhouse unit for each of the four vegetable crops analyzed, *viz.*: 1) gross income from sales (total returns), 2) positive cash flow after paying total costs of production, and, 3) positive cash flow as a percentage of sales.

The final column in Table 7 projects profit levels for a well-managed High-Tunnel Greenhouse Enterprise with 5 greenhouses (3 for Okra) of 500M^2 each. It is assumed that the enterprise consistently achieves targeted yields, and that it is managed and operated by one full-time person, employing limited amounts of casual labor primarily at planting and harvest. As shown, profit levels for such a full-time out-of-season production enterprise range from about $4,000 when producing eggplants to more than $7,000 when producing Okra. As owner-operators gain experience, a full-time high-tunnel greenhouse enterprise can be expected to add additional greenhouses, thereby increasing profit levels.

Table 7: Projected Annualized Performance Targets for High-Tunnel Greenhouse Production *in Central Iraq, selected crops*

Annual Performance Results ($US-two crops)	Total Sales (Returns)	Positive Cash Flow	Cash Flow as % of sales	Enterprise Profit levels
Tomatoes	3,010	1,087	36.10%	5,435
Cucumbers	3,053	1,021	33.40%	5,105
Eggplants	2,760	833	30.40%	4,165
Okra (1st+ratoon)	5,425	2,398	44.20%	7,194

Source: Anka Wholesale Prices 2009, Inma Seasonality Study for Horticultural Produces

Appropriate technical assistance and training received by owner-operators undoubtedly will heavily influence yield levels achieved, and thus profitability. Marketing strategies also strongly influence profitability levels. As more high-tunnel greenhouses come into production, diversification into other vegetables can assist to avoid oversupply of the four most popular vegetables reported herein. The Inma Horticulture Team already is planning to provide technical assistance and training for alternative vegetable crops.

High-Tunnel Growth Potential

Out-of-season vegetable production capacity in Iraq has been increasing rapidly. Both donors and private sector businesses have been importing increasing numbers of high-tunnel greenhouse units. Inma estimates that during 2008 and 2009, out-of-season production capacity in Iraq doubled from an estimated 5,000 high-tunnel units to more than 10,000 over this two-year period. Since then, increases in number of units being installed continue unabated. This is despite the fact that until now, no objective information has been available about profitability and financial sustainability under Iraqi conditions. This rapid growth in out-of-season production capacity has raised concerns about market saturation during the "out-of-season" market windows. Saturation would result in steep price declines and reduced market opportunities. In consequence, high-tunnel producers would lose money and many would go out of business.

Inma projections of the "absorption capacity" of out-of-season consumer markets for Iraqi production of tomatoes, cucumbers, eggplants and okra are presented below. Several market variables have been considered in making these estimates (i.e., current and projected vegetable consumption levels, national and regional demographics, consumer food demand patterns, and strength of competition by imports arriving from Syria, Iran, Jordan and Turkey (especially in light of continuing subsidy patterns in those countries).

As shown in Table 8, below, Inma projects those high tunnel greenhouse units in central and southern Iraq, (producing tomatoes, eggplants, cucumbers and okra) can expand from the current 10,000 units to 25,000 units without an appreciable negative impact on market prices. Inma also projects that Northern Iraq high-tunnel units (with specialized construction to operate under colder conditions) can expand by some 9,000 units without saturating that market.

Table 8: Estimated Maximum Number of High Tunnels in Production to Avoid Market Saturation, by Province and by Selected Crop, Central and Southern Iraq (Inma Projections).

Crops	Ninawa	Kirkuk	Diyala	Anbar	Baghdad	Babil	Karbala
Tomato	841	437	314	455	2,609	372	311
Okra	214	111	80	116	773	95	79
Eggplant	353	183	132	191	1,201	147	123
Cucumber	335	174	125	181	999	122	102
Total	1,743	905	651	943	5,583	735	615
Crops	Wasit	Salah ad Din	Muthanna	Dhi Qar	Maysan	Basrah	Total
Tomato	324	246	152	490	273	910	7,733
Okra	82	63	39	124	69	231	2,075
Eggplant	128	97	60	193	108	359	3,273
Cucumber	106	81	50	161	89	299	2,825
Total	640	487	300	968	539	1,798	15,907

Source: Inma Projections using COSIT Data