YEMEN: Agricultural Policy Review

Working Paper Number I

Basic Facts -
Economics of Crop Production in Yemen

by

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YEMEN: Agriculture Strategy

Working Paper on Basic Facts

Economics of Crop Production in Yemen

A. Introduction

Under the agricultural policy review, the competitiveness of priority crops has been analyzed in a joint effort of the General Directorate of Planning and Monitoring in the Ministry of Agriculture and Irrigation (MAI) and the World Bank in April/May and June 1998. Results of this analysis, which is based on domestic resource costs (DRC), are presented in this report. The evolving character of the analysis requires further work to (i) include additional field crops in the analysis, and to (ii) verify and, if necessary, adjust the basic physical parameters and price assumptions. The staff of the MAI participated in all phases of this complex task, and the World Bank provided guidance throughout the process. GTZ and FAO agreed to follow-up on the work and to provide support for the MAI.

The analysis of the competitiveness of crop production is based on the calculation of DRCs. A set of more than 100 crop budgets has been prepared as a contribution for the DRC analysis. These crop budgets are available to the MAI, and they are used for a crop budget handbook for Yemen which is currently under preparation. Similar handbooks have been prepared with FAO support for Jordan and Syria (for Egypt, a crop budget handbook is currently under preparation), and experience of these countries indicate that there is a high demand for such a source of information. A draft of the crop budget handbook for Yemen is expected to be distributed at the end of the policy review process. It will be an important tool for further policy analysis, e.g., to simulate changes in input or output prices on farmers' income, and its final version is expected to be utilized by the extension and research service. Due to this, the extension staff could broaden its service to financial aspects of crop production.

An important additional output of the entire task is the capacity building process in the MAI. The task team in the MAI is now qualified to carry out similar work in the future with minimum outside advice. The MAI staff should maintain, extend and update the crop budget handbook in the future. This would assist the MAI (i) to streamline its currently inefficient and unreliable statistics and (ii) to establish a close cooperation with other institutions, e.g. AREA in Dhamar.

This report presents first results of the economic analysis of crop production and describes the methodology and data source of the analysis. It consists of the following five parts: (1) explanation of the DRC concept, (2) presentation of the methodology and data source, (3) assumptions and calculation of shadow prices, (4) summary of the results, and (5) conclusions and recommendations for further analysis.

B. Domestic Resource Costs

The economic analysis of crop production is based on DRCs. This is the most used measure of the efficiency of domestic farm production relative to the international market. The DRC calculation indicates (i) whether the economy saves foreign exchange from local production, i.e., it answers the question whether a specific product should be imported or domestically produced, or (ii) whether the economy earns foreign exchange from exporting local production, i.e., it answers the question whether a specific product should be exported. The DRC measures how much domestic resources (e.g. labor, land, and water) are used to earn or save a unit of foreign exchange. If the DRC is less than one, it is better to produce in Yemen than to import, or, when applicable, to export a specific product. If the DRC is greater than one, it is better to try to produce something else that uses domestic resources more efficiently. A DRC of 0.68, for instance, indicates that domestic resources with a value of US$ 0.68 are required to earn or save US$ 1 of foreign exchange.

The DRC analysis is an important tool to support policy makers as it provides information on the economic competitiveness of sub-sectors and single crops. If a country has a comparative advantage in a commodity, it should either produce it or expand its production; if it does not has a comparative advantage, it should not produce it or expand its production. This argument is made strictly in efficiency terms, and other considerations such as welfare, risk, or security are not included. Other important factors which should guide policy makers are: consumer preferences for certain varieties of crops and traditional consumption patterns, farmers' access to input and output markets, availability of water as well as access to water, local agro-ecological conditions which determine the cropping cycle and local farming systems, and technical skills as well as preferences of farmers.

C. Methodology and Data Source of DRC Analysis

The DRC analysis consists of the following four steps: (i) identify priority crops for which a DRC calculation has to be conducted, (ii) collect and, subsequently, translate crop budgets in a comparable format, (iii) collect market prices of tradable and non-tradable goods and calculate shadow prices for these goods, and (iv) carry out the DRC calculation. For this report, time constraints did not allow the collection of primary data.

i. Priority Crops:

The task team in the MAI identified priority crops for the three agro-ecological zones in Yemen. According to AREA in Dhamar, these zones are the Coastal Area (CA), the Highlands (HL), and the Eastern Plateau (EP). The selection of priority crops for the three agro-ecological is based on the official agricultural statistics. Unfortunately, the official statistics do not follow AREA classification of the agro-ecological zones for it contains information on a governorate level; the boundaries of the governorates are not in accordance with the boundaries of the agro-ecological zones. The task team allocated the governorates to the agro-ecological zone in which the main part of their agricultural land is located:

Coastal Area (CA): Al-Hodeidah, Lahj, Abyan, Al-Mahara and Aden;
Highlands (HL): Sana'a, Hajjah, Sadah, Al-Mahwit, Dhamar, Ibb, Taiz and Al- Beida; and
Eastern Plateau (EP): Mareb, Hadramawt, Al-Jawf and Shabwa.

The selection of priority crops was presented and discussed during a workshop in Dhamar (in April 1998) with experts from AREA. As a result of this workshop and the preceding analysis, the following priority crops have been selected:

أ. Coastal Area (CA): Millet, Sorghum, Tomatoes, Onion, Banana, Oranges, Cotton, Sesame;

ب. Highlands (HL): Maize, Millet, Sorghum, Wheat, Grapes, Tomatoes, Potatoes, Onion, Cow Peas, Qat, Coffee, Alfalfa; and

ج. Eastern Plateau (EP): Sorghum, Wheat, Dates, Tomatoes, Potatoes, Onion, Alfalfa.

(The following products are not included in the DRC analysis but were identified as priority products: tobacco, peaches, pomegranates, lentils, apricots, and fodder-sorghum. The MAI task team should prepare crop budgets for these crops in order to include these products in the DRC analysis).

ii. Crop Budgets

A DRC analysis requires information on the basic input and output parameters of crop production. The common format to compile and present this information are crop budgets. Time constraints did not allow the collection of primary data for crop budgets. For the purpose of this study, a serious effort has been made to gather reliable crop budgets from recent project preparation reports which were prepared by the World Bank, FAO, IFAD, GTZ, AREA and the MAI (see Annex for a list of the reports).

The crop budgets are based on field surveys and represent the current production technology and intensity. In addition, yields and input use under improved production technologies are projected, based on findings of the research and extension stations in Yeme. Crop budgets for improved production technologies are also included in the DRC analysis. Due to this it is possible to analyze whether an improved technology has the potential to lead to a higher efficiency in the use of domestic resources.

The technical parameters of the crop budgets have been discussed and approved by AREA experts in Dhamar during a workshop. The in-depth expertise of the AREA staff was useful to evaluate and adjust the yield and input intensity in the crop budgets. Furthermore, data gaps for labor and machinery input were filled with AREA support.

In the next step of the DRC analysis, the crop budgets are adjusted and translated in a comparable format, based on crop budget handbooks for Jordan and Syria. The setup of a comparable format is necessary for the formats of the original crop budgets are diverse and do not contain the same set of information. AREA in Dhamar supported the standardization of the crop budgets, e.g. related to the use of machinery or draft animals, or the input of family and hired labor.

A problem that is not solved yet is the lack of detailed information on monthly labor and machinery requirements. Due to this, it was not possible to follow exactly the FAO crop budget format. While the DRC calculation does not require this detailed information, further work of the task team on the crop budget handbook should aim to complement the existing information.

The original crop budgets that are gathered from the different reports do not contain information on land ownership and whether the farmers are well owners. The standardized crop budgets imply that farmers own the land. For the DRC analysis, however, land is valued at 25 percent of the main output, e.g. grain, that is produced on it (see explanation below). Furthermore, the crop budgets imply that farmers who irrigate their land have to buy water from well owners. Due to this, the cost of irrigation are based on the farmgate price of water and include the cost of fuel and equipment for the pump and conveyance system as well as the well owners' margin.

iii. Market and Shadow Prices

DRC analysis requires information on the cost of tradable and non-tradable resources, at market as well as shadow prices, which are necessary to produce a unit of a specific product. The

official statistics do not contain reliable and consistent price information. Various departments in the MAI, for instance, publish different price information for the same product, region and year. Furthermore, the prices published by the MAI are market prices. For the DRC analysis, price information on the farmgate level is required. The farmgate prices which are used for the DRC analysis are therefore "best estimates" based on consultations with the Market Information Center, the General Department of Statistics and Documentation in the MAI, the Ministry of Supply and Trade, the Public Corporation for Agricultural Services, AREA staff in Dhamar, and several Departments in the MAI. The set of farmgate prices is complemented with information which is taken from various project reports.

All prices used for the crop budgets refer to the average price level in 1997. Market prices are adjusted either by calculating import or export parity prices, or by direct calculation of shadow prices based on information provided by the staff in the MAI. For the DRC analysis, inputs as well as outputs have been shadow priced. The annex contains a table with the full set of price data.

Outputs:

Main Product: Based on commodity price data published by the World Bank, import parity prices are calculated for wheat, maize, sorghum, and export parity prices for coffee and cotton, to arrive at economic prices. Market prices for Saudi Arabia are used to calculate export parity prices for bananas, oranges, onions, potatoes and tomatoes (see annex). The DRC calculation for all other crops is conducted with local prices. This implies that these products are either non-tradable goods or tradable goods which are not traded. In spite of that, small quantities of several fruit and vegetables, e.g. grapes, papaya and dates, are exported to Djibouti, Saudi Arabia and other Gulf States. For further analysis, it is recommended that the task team collects market prices in the most important export markets for the respective products.

By products: An important by product of cereal production is straw. Straw is used as an input for livestock production in the highly integrated Yemeni farming systems and improves the economic viability of cereal production. The reason why farmers produce cereals is not only because of the grain but also because of the by-products, e.g. straw. By-products are traded on a local level and have a market price. For the DRC analysis, market prices of by-products are not adjusted.

Inputs:

Seeds: The government provides certain seeds at subsidized prices to the farmers. Markets of the respective seeds are therefore distorted by government intervention. Internal documents of the MAI reveal, for instance, that the market price for 1 kg sorghum seeds amounts to YRls 50 while the production costs are YRls 70. For the DRC analysis, market prices for subsidized seeds are adjusted.

Fertilizer: Based on commodity price data published by the World Bank, import parity prices are calculated for urea, TSP and potassium sulfate. The price of manure is not adjusted, i.e. the shadow price equals the market price.

Pesticides: The Public Corporation for Agricultural Services provided information on the import parity price and the market price of pesticides. Since the price of pesticides varies, an average price is used for the DRC analysis. The market price of pesticides is YRls 1,750 per kg or liter, the respective shadow price is YRls 1,050.

Water: Cost of water comprise the expenses for fuel and machinery as well as the well owners' margin. The composition of cost is 46 % fuel, 18 % labor and 36 % depreciation and the well owners' margin. A conversion factor of 1.8 is applied to calculate the fuel component at shadow

prices. This conversion factor is based on IMF estimates. The shadow price of labor is set to be 50 percent of the market price. The shadow price of the remaining component is set to be the same as the market price. The imputed market and shadow price of 1 cum. water is thus YRls 5 and YRls 6.5 in the CA, YRls 7 and YRls 8.9 in the EP, and YRls 10 and YRls 12.8 in the HL. The differences in the pumping depths explain the different price levels in the three regions.

Machinery: Draft animals are assumed to be non-traded goods and their shadow and market prices are equal. In contrast, tractors, machines and the energy to run the machines are tradable goods. Thus, costs of machinery are calculated at both shadow and market prices. Machinery costs consist of energy, labor and depreciation and the machine owners' margin. The calculation of the shadow price of machinery follows the same methodology as for water. The composition of cost is 60 % fuel, 15 % labor and 25 % depreciation and the machine owners' margin. The market price of one hour hired machinery is YRls 600, the shadow price is YRls 843.

Labor: the price of labor varies from region to region and fro crop to crop. The price of one day hired labor amounts to YRls 400 in the HL and EP and to YRls 350 in the CA. Labor is cheaper in the CA because of the high oversupply of labor. Qat production and harvest requires extra skills so that the price of labor is YRls 600 per day. The shadow price of labor is estimated at half the market rate in all cases due to the dominance of family labor with low alternative production possibilities.

Capital: the market and shadow price of capital is taken as the prevailing bank deposit rate of 15 percent in the local market, as there is no general capital shortage and the Riyal is effectively a tradable currency. Imputed cost of capital is calculated on the value of purchased inputs (chemicals, tractor hire, water) for six months.

Land: market and shadow price of annual rent of land without water is set at 25 percent of the gross value of the crop, in line with a typicalrainfed land share-cropping contract.

Other Cost: The original crop budgets contain information on small cost items, e.g. for bags, transport containers, etc. The crop budgets used for the DRC analysis summarize these costs under the cost category "other costs". Other costs are assumed to amount to 5 percent of the value of the main output. These costs are assumed to comprise half tradable and half non-tradable resources. 50 percent of the non-tradable cost component is assumed to be labor, which is shadow priced according to the coefficient presented above.

D. Results

The results of the DRC analysis show that Yemen has a comparative advantage in producing (see attached table for results):

أ. *irrigated fruits in the CA and HL*, i.e. bananas, papaya and oranges in the CA, dates in the CA and EP, and grapes in the HL. DRCs for the these crops are below 0.6. The DRC analysis for bananas and oranges is based on economic border prices and indicates that Yemen has the potential to sell these products in export market, e.g. in Saudi Arabia as well as other Gulf states and Djibouti. To tap export markets, the timely delivery of sufficient quantities of quality products has to be guaranteed. Other countries in the region have a by far more developed export production or are currently implementing programs to strengthen the export production. To tap regional and international markets, Yemen has to develop its own export sector.
While discussing the advantages of these high value crops, it is important to keep in mind that the production of the potential export crops is (a) water intensive and (b) yields a low return

per cum. water. While the annual water requirements of bananas, for instance, exceed 40,000 cum. per hectare, the return per cum. water is only YRls 10 (YRls 12 for oranges and YRls 26 for papaya). Such a low return per cum. water is critical given the severe water scarcity in Yemen. In spite of that, fruits have generally a high area productivity and their production is labor intensive.
A socio-economic aspect related to banana production is the fact that it is mainly located in upper Wadis where the water supply is based on a combination of spate and controlled irrigation. Banana production in these areas is controlled by big land lords or Sheikhs and small-scale farmers do not have access to the water;

ب. *irrigated vegetables in all three agro-ecological zones*, i.e. tomatoes and onions in the CA, HL and EP, and potatoes in the HL and EP. Vegetables are an important source of income for small-scale farmers, they generate employment for their production is labor intensive, and they yield a relative high return per cum. water.
The crop budgets for the improved production technology indicate that there is a high potential to increase productivity of irrigated vegetables and, hence, to improve the efficiency of the use of domestic resources. This is of great importance as the government plans to lift the current import ban for vegetables, and low price vegetable imports are likely to challenge the domestic production, especially when an export country offers its excess supply on the regional market. With an improved production technology, domestic producers might be able to defend their share in domestic markets;

ج. *irrigated cotton in the CA and rainfed coffee in the HL*. The calculated DRCs for these cash crops are low and indicate that Yemen has a comparative advantage in producing coffee and cotton for export markets. However, market access, quality standards, special production skills and expertise, price fluctuations of international prices, and access to markets are only a few obstacles for Yemen exporters to tap these markets. The low DRCs for these crops may, therefore, be misleading if the required production technology cannot be applied or markets prove to be very narrow. However, the results of the DRC analysis indicate that private sector activities to enter export markets for these products are worth to be supported by the government. The prospects for coffee exports to Europe or North America should be studied since Yemen has the potential to produce premium quality and to build upon its history as the first nation that exported coffee.
While coffee and cotton do not have the potential to increase the incomes of a broader segment of the rural population, they can play an important role as a niche product in certain production regions in Yemen;

د. *rainfed cereals*, i.e. maize, sorghum, barley and wheat in the HL, and millet and wheat in the CA. Rainfed cereals are the most important crops in the HL. Cereal production is essential for the supply of households with food and a large part of the farm production is consumed by the farm household. The straw is used as an input for the livestock sector or as fuel. Rainfed cereal production is characterized by low yields and low input use, hence overall production intensity is very low. These production systems are well adopted to the unpredictable weather conditions in the HL, with erratic rainfalls and long drought periods.
A quick shift to a higher production intensity based on modern high yield varieties and a high input of machinery is not recommended. The traditional cereal varieties are drought resistant and have proven that they are suitable for the extreme production condition in the HL which is characterized by an uncountable number of micro-climates. Farmers reportedly use different cereal varieties for their plots depending on the respective micro-climate. A higher input of machinery is constrained by the small average size of the fields and the small terraces which are often not accessible for tractors.
The limitations to increase the productivity of rainfed cereals are confirmed by the crop budgets for improved production systems in the HL. DRCs based on these crop budgets are

only slightly lower than those for the current production technology;

هـ. *supplementary irrigated sorghum in the CA*. While the DRC analysis proves that Yemen has no competitive advantage in producing irrigated cereals, supplementary irrigated sorghum is the only irrigated cereal crop with a DRC lower than one. Because of the land and water scarcity in the CA, the low return per cum. water and per hectare, and the labor extensive production technology of sorghum, Yemen's constrained land and water resources may be better utilized with the production of high value and labor intensive products;

و. *irrigated Qat in the HL*. The DRC analysis proves that the domestic resources are efficiently used by the production of Qat. The farmgate price of one bundle Qat is conservatively assumed to be YRls 100. Currently, there is no official or systematic collection of Qat prices in Yemen, and the large number of Qat varieties, i.e. more than 300, makes it difficult to collect and calculate an average price. In a sensitivity analysis, a higher farmgate price of Qat, i.e. YRls 300, is assumed. At this price level, the DRC of Qat would be similar to those of the most competitive crops in Yemen, i.e. coffee, oranges, banana and cotton. Up to now, crop budgets are not available for rainfed or supplementary irrigated Qat. However, these production systems are likely to yield a very low DRC;

ز. *irrigated Alfalfa in the HL and EP*. Alfalfa is an important input for the livestock sector. It is sold on rural markets and prices are commonly high. Alfalfa is a water intensive product and annual water requirements are as high as 24,000 cum. However, the returns per cum. of water are higher than those of most of the irrigated fruits; and

ح. *irrigated oilcrops in the CA.* Sesame is currently an important crop for the farmer in the CA. The DRC analysis indicates that the use of domestic resources is efficiently under both the current and the potential production technology.

The DRC analysis shows that Yemen has a comparative advantage in producing the following products under improved husbandry and yields:

أ. *supplementary irrigated pulses* in the HL, i.e. cow peas. [The price assumptions for cow peas have to be revised]

On the other hand, the DRC analysis shows that Yemen has no comparative advantage in producing:

أ. *irrigatcereals*, i.e. wheat in the HL and EP, sorghum in the CA and EP, and maize in the HL. Yemen has a comparative advantage in producing cereals under rainfed production systems which are adopted to the agro-ecological conditions. Yemen's scarce water resources should be used for the production of high value products, cereal production should be limited to the rainfed areas;

ب. *supplementary irrigated cereals*, i.e. wheat in the HL. Even with a reduced water input, the production of supplementary irrigated wheat is not profitable; and

ج. *irrigated pulses* in the HL, i.e. cow peas. [The price assumptions for cow peas have to be revised.]

Further findings of the DRC analysis are that:

أ. The efficiency of crop production is sensitive to changes in water prices. The quantity of water used for irrigation is therefore an important determinant for the profitability of crops. Given the water scarcity in Yemen and the declining trend in its non-renewable water resources, water prices are likely to increase. Water saving is thus an important measure to save costs and to sustain the efficiency of the use of domestic resources. Given the declining trend in water tables, the water saving issue will become even more important in the future;

ب. The profitability of several crops is highly sensitive to small changes in farmgate prices of the main output. The price risk affects notably producers of vegetables and fruits. Wholesale and retail prices of these products are prone to daily fluctuations. This is well documented in the official price statistics. Since price fluctuations are transmitted to the farm level, farmers experience income losses when an unexpected price drop occurs. Access to information on market prices and overall transparency of markets is therefore important to stabilize market prices and to reduce the price risk for producers of vegetables and fruits; and

ج. The potential to improve the efficiency of the use of domestic resources through changes in the production technologies is limited. Crop budgets for cereals which are produced under rainfed agriculture, for instance, show only a small reduction in DRCs compared to its current level when the production intensity is increased. The potential to reduce the DRCs and, consequently, improve the efficiency of the use of domestic resources is significantly higher for irrigated crops. Nevertheless, it is important to consider that only for cow peas a shift from the current to an improved production technology could move the DRC under the threshold (i.e. of one).

E. Conclusion and Next Steps

أ. The DRC analysis proves that most crops which are currently produced in Yemen use the domestic resources efficiently. Irrigated cereals, however, do not utilize the domestic resources efficiently and their production should not be supported by the government or by the extension and research services;

ب. Research and extension activities should focus on products which use the domestic resources most efficiently and, at the same time, yield a high return to the inputs used for their production;

Next Steps for 1998

ج. review the physical parameters of the crop budgets;

د. prepare a draft of the farm data handbook with advice from FAO or a senior consultant. This farm data handbook should contain a short introduction, a chapter on Yemen’s agriculture, a description of the three agroecological zones, a table with all price information, and a collection of crop budgets;

هـ. prepare an inventory of information gaps, e.g. monthly input requirements, crop budgets for certain regions, crop budgets for certain types of water supply, e.g. water harvesting, spate, spring, dams and base flow diversion, and groundwater irrigation, information on fixed cost of farm production, etc. This inventory should be used as a basis to define the workprogram for 1999;

و. distribute a draft of the farm data handbook to a broad audience. Ask for comments and, if appropriate, organize small workshops. Summarize all comments and attached the comments to the list of information gaps;

ز. assess options whether other institutions can be involved in the preparation of the farm data handbook for 1999; and

ح. define clear responsibilities in the MAI team, e.g. two staff member responsible to maintain the crop budget data base, two staff members for the price data base, two staff members for the chapter with basic data, etc.

Next Steps for 1999

ط. review the comments received and the existing data gaps and prepare TOR for a consultant. Seek support from FAO. Start early in the year;

ي. Once the consultant is available, prepare a workprogram with realistic deadlines. Discuss the workprogram in the MAI with the Directors of the Departments to get their commitment for support, e.g. to provide a certain type of information, the organization of a visit to a field station, etc. The consultant should work closely with the team and should help to design the workprogram. After the workprogram has been agreed upon, the MAI team should be provided with the necessary financial and logistical resources (for copies, communication, transport, etc.), time (relief from their daily work burden) and financial incentives (additional payments to their regular salaries) to achieve the objectives defined in the workprogram;

ك. a workshop could be organized to discuss the new information;

ل. the additional material should be analyzed and reviewed to complement the draft of the farm data handbook. The revised farm data handbook should then be distributed; and

م. clarify whether the farm data handbook can benefit from the agricultural census.

Next Steps for the DRC analysis

ن. The DRC analysis is a static measure of the competitiveness of domestic farm production. Since the domestic and international political and economic environment is dynamic, the DRC analysis may require adjustments in the future. For instance, Yemen is implementing a liberalization program which will cover several agricultural sub-sectors. This program will change the trade regime for fruits and vegetables and the subsidy system for imports of wheat and wheat flour. Fluctuating international prices will change the DRCs as well. With limited external advice, the MAI staff should have the capacity to update the DRC calculation; and

س. The agricultural production systems in Yemen are based on livestock and crop production. In order to put the analysis of individual crops and livestock into the perspective of feasible crop rotations, the analysis of the competitiveness of crop rotations should be considered.

ANNEX:

Data Source:

Crop budgets are based on information that was gathered from the following sources:

World Bank, 1997, Republic of Yemen, Southern Governorates Rural Development Project, Working Papers;

World Bank, 1997, Republic of Yemen, Seeds and Agricultural Services Project, Working Papers;

World Bank, 1993, Republic of Yemen, Agricultural Sector Study: Strategy for sustainable Agricultural Production, Volume II, Annexes and Statistical Data;

GTZ/IDAS Project: Gross Margins Calculations for Chilies, Cotton, Ground Nuts, Melons, Okra, Onion, Sesame, Sorghum, Tomatoes - Based on Crop Cutting Surveys in Abyan and Lahaj Governorates in the Agricultural Season 1996/1997;

FAO/AREA, 1997, Crop and Farm Budgets, Land Utilization Aspects and Possibilities for Farming System Improvements in an Area Covered by Quarter Degree Sheet 1444C;

IFAD, 1996, Republic of Yemen, Raymah Area Development Project, Pre-Appraisal Report, Annexes;

Table: DRCs and Gross Margins of Priority Crops in Yemen - Results

	Water Supply	Agro-Ecological Zone	DRC		Gross Margin (YRls)	
			Present Yields	Potential Yields	Present Yields	Potential Yields
Yemen has a comparative advantage for:						
Cotton	irrigated	Coastal Area	0.13	0.11	19,954	51,803
Coffee	rainfed	Highland	0.35	n.a.	379,350	n.a.
Bananas	irrigated	Coastal Area	0.38	n.a.	70,361	n.a.
Oranges	irrigated	Coastal Area	0.43	0.36	78,120	193,900
Bananas	irrigated	Coastal Area	0.43	0.30	3,150	146,550
Grapes	irrigated	Highland	0.46	0.44	608,300	827,000
Qat	irrigated	Highland	0.46	n.a.	640,220	n.a.
Tomatoes	irrigated	Eastern Plateau	0.46	0.36	331,800	57,800
Papaya	irrigated	Coastal Area	0.48	n.a.	653,583	n.a.
Dates	irrigated	Coastal Area	0.49	n.a.	95,500	n.a.
Potatoes	irrigated	Eastern Plateau	0.51	0.40	365,400	692,200
Millet	rainfed	Coastal Area	0.53	0.42	37,570	50,380
Maize	rainfed	Highland	0.54	0.54	45,800	57,110
Onions	irrigated	Highland	0.55	0.48	495,200	688,720
Alfalfa	irrigated	Eastern Plateau	0.57	0.54	429,677	565,392
Onions	irrigated	Eastern Plateau	0.57	0.53	276,622	367,804
Potatoes	irrigated	Highland	0.60	0.49	310,000	513,750
Dates	irrigated	Eastern Plateau	0.61	n.a.	115,049	n.a.
Tomatoes	irrigated	Highland	0.61	0.43	223,350	414,,050
Qat	irrigated	Highland	0.65	n.a.	428,250	n.a.
Tomatoes	irrigated	Coastal Area	0.65	0.54	124,048	194,998
Onions	irrigated	Coastal Area	0.65	0.51	216,101	397,954
Alfalfa	irrigated	Highland	0.72	0.58	365,665	584,665
Wheat	rainfed	Highland	0.79	0.78	22,300	26,205
Sorghum	rainfed	Highland	0.79	0.73	35,800	48,950
Sesame	irrigated	Coastal Area	0.85	0.57	58,010	124,608
Barley	rainfed	Highland	0.89	0.97	15,600	44,680
Sorghum	suppl. irri.	Coastal Area	0.91	0.78	44,219	59,467
Yemen has no comparative advantage unless husbandry and yields improve for:						
Cow Peas	suppl. irri.	Highland	1.24	0.91	35,400	54,050
Yemen has no comparative advantage even under improved husbandry for:						
Sorghum	suppl. irri	Eastern Plateau	1.56	1.37	24,194	35,260
Sorghum	irrigated	Coastal Area	1.40	1.11	34,219	48,217
Wheat	suppl. irri.	Highland	1.67	1.36	30,700	39,800
Sorghum	irrigated	Eastern Plateau	3.54	2.72	10,194	19,510
Wheat	irrigated	Highland	very high	very high	(4,300)	4,800
Wheat	irrigated	Eastern Plateau	very high	very high	(10,286)	3,912
Cow Peas	irrigated	Highland	very high	2.02	5,400	29,050
Maize	irrigated	Highland	very high	2.38	33,350	77,850