MPRA
Munich Personal RePEc Archive

More efficient production subsidies for emerging agriculture in micro Arab states: a conceptual model

Raboy, David G. and Basher, Syed Abul and Hossain, Ishrat and Kaitibie, Simeon

Qatar Central Bank

17 May 2012

Online at https://mpra.ub.uni-muenchen.de/38854/
MPRA Paper No. 38854, posted 17 May 2012 11:43 UTC

MORE EFFICIENT PRODUCTION SUBSIDIES FOR EMERGING AGRICULTURE IN MICRO ARAB STATES: A CONCEPTUAL MODEL

David G. Raboy,[1] Syed Abul Basher,[2,3] Ishrat Hossain,[3,4] and Simeon Kaitibie[3,4]

DRABOY@PATTONBOGSS.COM, BASHERS@QCB.GOV.QA , ISHRAT@QU.EDU.QA, KAITIBIE@QU.EDU.QA

Abstract. Import-dependent arid Arab micro states such as those in the Persian Gulf are particularly vulnerable to food-security risk. Among the many remedial policy suggestions is some initiation or increase in domestic production to insulate these countries from supply disruption, import price volatility and high import prices. This paper does not address the efficacy of domestic production but notes that such production will require government intervention in the form of production subsidies to mitigate market risk. The narrow focus of this paper is to provide a conceptual model of subsidies that avoids many previous problems in established subsidy systems. The paper describes a subsidy model that makes the most use of market signals, avoids perverse incentives, and provides a structure to encourage efficiency, quality enhancement and product differentiation in agricultural products. The system is designed to be WTO compliant. The model has two components: a calculation of the true economic cost of a unit of an agricultural product and a deficit payment that is calculated to bridge the gap between true economic cost and market remuneration. The structure of the deficit payment is crucial to the establishment of a beneficial incentive system. The paper provides a mathematical rendering of the model, analysis of the associated incentive structure and a numerical example for a hypothetical Arab micro state.

Keywords: Production subsidies; Arab micro states; Cost of capital; Economic efficiency.

[1] Corresponding Author. Work performed while seconded as Chief Economist to the Qatar National Food Security Programme (QNFSP), Doha Qatar. Permanent affiliation: Chief Economic Consultant, Patton Boggs LLP, Washington DC, USA. Phone: Office +1-202-457-6508, fax +1-202-457-6315, mobile +1-703-919-1098. email draboy@pattonboggs.com. Address: Patton Boggs LLP, 2550 M Street NW, Washington DC 20037, USA.

[2] Qatar Central Bank, Doha Qatar.

[3] Qatar National Food Security Program, P.O. Box 923, Doha, Qatar.

[4] Qatar University, Doha Qatar.

1. BACKGROUND

During the food crisis of 2007/2008 some observers opined that the import-dependent Arab world was particularly hard hit by food disruptions, high prices and price volatility. (World Bank 2009) Many food-security proposals emerged, including increased strategic storage, forward contracting, enhanced import diversification, improved logistics and other measures. Some policy makers suggested at least a non-trivial level of domestic production to assist in insulating Arab countries from the effects of external price volatility and export prohibitions that resulted from total or near total import dependence. (World Bank 2009) The problems that must be overcome to enhance domestic production in Arab countries, however, are daunting—water scarcity, arable land constraints, lack of efficient distribution systems, trade barriers, access to capital, market risk, etc. These problems are exacerbated by scale issues that confront Arab micro states such as the majority of those in the Gulf Cooperation Council (GCC).[5,6]

Embryonic agricultural development, especially in micro states, will almost certainly require some level of government intervention, in particular production subsidies. This paper does not opine on or analyze the efficacy, or desirability, of domestic production in Arab micro states, but rather considers situations where decisions have been made to develop at least some domestic production, or states where such production already exists but existing subsidies may be highly inefficient.[7]

The United Arab Emirates (UAE) already has a fairly substantial agricultural sector. Some 70,000 hectares are under cultivation (latest figures—2009) producing about 2 million tonnes of agricultural products, including 1.6 million tonnes of field crops, over 170,000 tonnes of vegetables and almost 280,000 tonnes of fruit. In addition, the UAE has developed livestock with over 4 million head of sheep, goats, and cattle. (UAE 2012)

---

[5] Some have proposed greater cooperation in purchasing among GCC states to achieve the economies of purchasing power scale necessary to mitigate import price volatility and other food security dilemmas that result from lack of scale. It is beyond the purview of this paper to analyze this possibility, and heretofore cooperation has proved illusive, but it is surely a desirable topic for further research.

[6] These include countries such as Bahrain, Kuwait, Oman, Qatar and the United Arab Emirates (UAE), all having miniscule populations. According to Streeten (1993), a country is considered to be "small" if its population were less than 10 million people. Save for the UAE, the Arab micro states we consider have populations much smaller, in the 2 to 3 million range and therefore we refer to them as micro states.

[7] It is also beyond the purview of this paper to opine on the geopolitical implications of food insecurity in micro GCC countries, some of whom are quite wealthy. Suffice it to say that these countries are major energy suppliers, that their energy sectors are highly dependent on expatriate human capital, and that the foreign work force is affected by food-security issues. Debating whether food-security can be ignored in wealthy GCC micro states is a subject for an entirely separate paper dedicated to that subject.

The State of Qatar has embarked on a national initiative to develop some level of domestic production for food security purposes. The Qatar National Food Security Programme (QNFSP) envisions employing industrial scale solar plants to power desalination facilities dedicated to agricultural irrigation. Coupled with high-tech production methods such as hydroponics, QNFSP proposes to start what would effectively be a new agricultural sector to augment increased strategic storage and rationalization of imports. The initiative is still in the concept phase and no production has yet occurred, although Qatar does currently produce some fruits and vegetables. (QNFSP 2012)

Kuwait has developed agriculture in certain sectors. The latest data (2006/2007) show 684,000 tonnes of production of vegetables and field crops, 37,000 tonnes of meat and over 200,000 tonnes of eggs and dairy items. (IMF 2011) Much of the meat production is in poultry.
As stated, it is well beyond the scope of this paper to assess the desirability of domestic agricultural production in Arab micro states, which would require a social cost-benefit analysis. Whether ill advised or not, if such production is to occur production subsidies will be necessary, and it is in the interests of these micro states to design them properly, so as not to squander scarce resources. Therefore the limited goal of this paper is to present a conceptual model of production subsidies that diminish inefficiency and perverse incentives, encourage quality enhancement, minimize budgetary expenditure, and are WTO compliant. The paper's focus is on subsidies in Arab micro states such as those in the GCC. We refer to productions subsidies as contained in a Market Stabilization System (MSS).

Production subsidies will be required for several reasons. First, the resource scarcity and distribution problems previously mentioned are serious. Second, scale is a complicating issue in micro-states. The same small scale that makes import diversification difficult—leading to high and volatile import prices—results in production-efficiency issues for some products and distribution-chain problems. Third, competing imports are often subsidized.

In a sense, government intervention through production subsidies is a reasonable component of a Public Private Partnership (PPP) system. PPPs have addressed enhancing access to the supply chain for small-holder producers (Rich and Narrod 2010), and promoting food safety and quality control through collective action, involving government and private sector entities. (Narrod *et al*

2009) Production subsidies are one form of mitigating market risk—a legitimate PPP function; akin in some respects to long-term, fixed-price contracts.[8]

Any MSS must avoid the historically created complexities, distortions, perverse incentives and massive budgetary problems that have been associated with, for example, the EU's Common Agricultural Policy, or the U.S. Farm Program. It also must not rely on subsidized or free inputs that lead to resource inefficiency, overuse, and may result in environmental problems. Input subsidies have been used in the UAE (UAE 2006) and Kuwait (USDA-FAS 2006) Micro states without a history of agriculture are ironically in the unique position of starting fresh when designing a MSS. The MSS described in this paper will bear little relationship to traditional domestic support systems in developed countries with mature agricultural sectors.

The goals of a MSS would be to make the greatest use of market forces, minimize perverse incentives that encourage inefficiency while discouraging product differentiation and quality enhancement, mitigate fraud possibilities, and maximize fiscal efficiency.[9] This analysis will describe, conceptually, a model for a hypothetical Arab micro state that we will denote as "Watan" that attempts to fulfill the goals just stated. Watan is a composite of GCC micro states. The paper will include a mathematical representation of the model, as well as provide a numerical example. The numerical example is for illustrative purposes only.

The remainder of the paper is organized as follows. Section 2 will introduce the conceptual MSS model. Section 3 will present the derivation of the full economic cost of a unit of a specific agricultural commodity. Section 4 will analyze the incentives associated with a few examples of deficit or truing-up payments—the subsidy required to fill the gap between market price and full economic cost. Section 5 will provide a numerical example of the model, including two of the options described in Section 4. Section 6 will offer discussion and consider future research.
To demonstrate concepts throughout the paper, we employ corn used as poultry feed as an illustrative commodity. Corn would initially appear an odd choice for an illustration of the MSS in arid Arab micro states, but we note that the UAE produces field crops on 28,000 hectares of

[8] Mitigating market risk is essential to food-security-related embryonic agricultural investments in Arab micro states. Given the emphasis on social, as opposed to private, returns, and limited market outlets, such investments bear many of the characteristics of "idiosyncratic" assets (Williamson, 1975) where lock-in and contractual-opportunism issues reign, and mitigation of market risk is especially crucial to private-sector investment.

[9] The latter two topics are not within the scope of this paper and are subjects for future research.

land, including over 240,000 tonnes of alfalfa, sorghum and corn. (UAE 2012) In 2005 UAE produced almost 19,000 tonnes of corn. (UAE 2006)

It is clear that production subsidies would be required for corn poultry feed production in Arab micro states given the lack of comparative advantage, allowing for a plausible demonstration of the model. In light of scale issues import diversification is very difficult for grains. For example Qatar imports about 90% of its corn from one country—Argentina.[10] This is further incentive for some domestic production.

Finally Gulf countries have shown an interest in expanding poultry production in part due to *halal* requirements and the expense of monitoring them on imports. Kuwait has, in recent periods, been 22 to 48% self-sufficient in poultry. (FAO 2010) Al-Nassar (2006) has stated: "The poultry industry in Kuwait is one of the leading food industries in the country. It consists of several poultry companies that vary between large, medium and small size poultry producers." In 2007, Kuwait's broiler production was on the order of 35,000 tonnes, and two companies were responsible for 75% of production. (USDA-FAS 2006) Currently the Kuwait poultry industry produces feed from corn imports subsidized by the government. This system is very expensive and drives up domestic poultry costs. (USDA-FAS 2006)[11]

Countries with existing or embryonic poultry sectors have stressed the need for secure supply sources for poultry feed, including enhanced domestic production. For these reasons corn poultry feed will be used in the numerical example contained in this paper but we in no way opine on the desirability of producing corn in the arid climates of Arab micro states; merely noting that it is being done and is agronomically feasible.

2. Derivation of the Conceptual MSS Model

The MSS system has two parts: 1) a "Full Cost Price" (*FCP*) which is defined as the true, all-inclusive economic cost of a unit of an agricultural commodity; and 2) a "Deficit Payment" which is a "truing up" to ensure that the farmer receives full economic cost remuneration in cases where the market price is insufficient. A crucial and differentiating aspect of the MSS described here is that whereas the *FCP* is calculated periodically, the Deficit Payment is

---

[10] Authors' calculations based on micro data provided by the Qatar Customs and Ports Authority, 2011.

[11] This was confirmed in an interview with Mutlaq Y. Al-Zayed, Deputy Managing Director, Kuwait Flour Mills & Bakeries in Kuwait City in April 2012. Kuwait Flour Mills operates the corn distribution program.

determined on a transaction-by-transaction basis. This is a key to maximization of market incentives, and avoids the problems associated with traditional domestic support systems where subsidies are set at the same level per unit for all producers, regardless of their structures, efficiencies, and business models. In the case of micro states, scale becomes an advantage in this area. The small market size makes transaction-by-transaction calculations feasible with even minimal use of information technology (IT) tools.

3. The *FCP* Model

The starting point for each crop will be the construction of a cost model which accounts for the economic cost of a unit of output—all variable and allocated fixed costs plus a cost of capital which reflects the minimum equity rate of return necessary to induce investors to make an investment in a farm (the "hurdle" rate, or opportunity cost of capital) and keep capital flowing to the enterprise. The output of each commodity model will be a *FCP* which reflects the total economic cost of producing a unit of a given crop.

The cost components that sum to the *FCP* can be divided into two broad categories: operating costs and "ownership" costs (otherwise known as the "cost of capital"). All costs are first calculated on a per-hectare basis (or equivalent basis based on standard size measurement), and then are converted to unit costs based on an analysis of yield. The general formula for a *FCP* of a specific commodity is:

$$FCP_m = \frac{\sum_{i(m)=1}^{V} v_{i(m)} + \sum_{j(m)=1}^{F} \left(f_{j(m)}/H\right) + \sum_{g(m)=1}^{C} \left(c_{g(m)}/H\right)}{Y} \qquad (1)$$

Where:

FCP_m = *FCP* for a unit of commodity *m*;

$v_{i(m)}$ = per-hectare variable cost of input *i* for commodity *m*;

$f_{j(m)}$ = total fixed costs of fixed-cost category *j* for commodity *m*;

H = total hectares; and

$c_{g(m)}$ = total capital costs for capital-type *g* associated with commodity *m*.

The methodology employed to calculate the cost of an agricultural commodity produced in Watan in this study was designed to be consistent with revised costing methodologies as derived in 2000 by a Task Force of the Agricultural & Applied Economics Association (AAEA) and published in a study entitled *Commodity Costs and Returns Handbook*. (AAEA 2000) The AAEA study is used by the United States Department of Agriculture (USDA) in the construction of all of its commodity-cost data bases. (USDA-ERS 2009)

3.1. Operating Costs

Operating costs include variable costs such as seed, fertilizer, fuel, lubrication, electricity, water, maintenance, pesticides and other chemicals, labor expenses; and allocated fixed costs such as those associated with accounting, management functions and general farm overhead. These costs can be generally derived from accounting data on a per-hectare basis.

3.2. Capital Costs

Some prior cost models of agriculture in the MENA region have assigned simple mark-ups to operating costs, or assumed percentage *ad hoc* return rates, to reflect the ownership or capital costs of a farm, which are then incorporated in the unit cost of a commodity. (Mazid and Aw-Hassan 2010) This may be appropriate in the case of small-holder agriculture, where family farms are passed from generation to generation (with property rights either formal or informal), and alternative economic opportunities for those associated with the farms are limited. In such cases both physical and human capital are subject to lock-in, in which case all returns over operating costs are essentially residuals. These residuals can be highly variable, and are not subject to modeling, as would be the case for opportunity cost. For this type of fact pattern, rules-of-thumb involving ranges based on rough averages may be the best option for assigning ownership costs.

In the case of countries like our hypothetical Watan, with embryonic agricultural sectors, agricultural investments are idiosyncratic, but there are many other alternative investment opportunities. Therefore the cost of capital must be modeled to include the equity returns necessary for investors to forgo alternative investments in favor of investment in agricultural facilities. This is best done by incorporating finance theory, including risk analysis and portfolio theory. (AAEA 2000)

There are many investment models that may pertain to Watan's embryonic agricultural sector. These include owner/operator, owner/contractor, Watan/foreign joint ventures, Direct Foreign Investment and regional investors treating minority or majority agricultural investments the same as any investment alternatives. To properly model the economics of farming in Watan, models must reflect a true economic cost of capital and in particular the opportunity-cost of investment. In this paper the starting point is the traditional user cost of capital approach. (Jorgenson 1963; Hall and Jorgenson 1967; Fullerton 1987) Recent literature has used this concept to model investment behavior in the farm sector. (Lewis *et al* 1988; Lagerkvist 1999) The user cost of capital is also referred to as the "implicit rental rate" and allows capital costs to be allocated to individual unit prices of agricultural products.

The concept behind the user cost of capital is the common finance one that an investor will only commit to an asset purchase if the associated cash-flow net-present-value (NPV) is non-negative when evaluated at an appropriate cost of capital. It is highly probable, and therefore assumed, that new investments in agriculture based on food security in a country like Watan will not be subject to tax. Therefore it is reasonable to model the user cost of capital under the assumption that the income flows from the resulting enterprises will not be taxed. In the absence of taxes, and stated in continuous time, the traditional cash flow expression to determine equilibrium NPV is:

$$q = \int_0^\infty c e^{-dt} e^{\pi t} e^{-\delta t} \, dt \qquad (2)$$

Where:

q = original asset cost;

c = rate of cash flow;

d = the nominal rate at which the investor discounts cash flows;

π = the inflation rate at which cash flows grow from the initial level; and

δ = the economic rate of depreciation, or an asset's loss of economic value as it ages.

Evaluation of the integral produces the classic formula for the user cost of capital:

$$c = q(d - \pi + \delta) \qquad (3)$$

d, the nominal discount rate, is the weighted-average cost of capital (WACC):

$$d = \omega i_D + (1-\omega) i_E \qquad (4)$$

Where:

i_D = the nominal debt interest rate associated with the financing of the farm asset;

i_E = the required equity rate of return (opportunity cost); and

ω = the share of debt in the total financing of the asset in question.

The rate of return on equity required to induce an investor to purchase an asset and to keep capital flowing to the enterprise, i_E, is modeled in this paper through use of the Capital Asset Pricing Model (CAPM). (Sharpe 1964; Lintner 1965)

CAPM has seen much use lately in modeling agricultural investment. The AAEA *Handbook* devotes a substantial amount of space to the use of CAPM in agricultural settings. (AAEA 2000, Chapter 2) A recent USDA-funded empirical study found CAPM very useful in modeling the returns received by agricultural cooperatives in the U.S. (Pederson 1998) The CAPM expression for an equity hurdle rate is provided in the data section.

4. Deficit Payment Options and Associated Incentives

A Deficit Payment is a mechanism by which a farmer is remunerated for any difference between the *FCP* and actual price the farmer receives in the market for a given commodity. The structure of a Deficit Payment can be a very thorny exercise, because the possibilities of inadvertently producing perverse incentives are rampant. In this section three, of many, options for Deficit Payments will be considered, and simple analytics are offered to depict the associated incentives. As previously stated the Deficit Payments occur on a transaction-by-transaction basis, as opposed to a system utilizing a flat, per-unit payment that is the same for all farmers and all transactions. This distinction substantially affects the incentives of any system, and is essential to make the most of market forces. Scale, as stated before, is an ally in the implementation of a transaction-based system.

Before discussing various options, it is worth noting a hypothetical nation such as Watan's WTO obligations with respect to agricultural subsidies. There are two types of subsidies relevant to our WTO consideration: "Amber-Box" subsidies tied to production levels and "Green-Box" subsidies that are typically lump-sum and not tied to production levels.[12] Developed agricultural producers were required to make Amber Box, but not Green Box, reduction commitments during the Uruguay Round. Arab micro states in situations similar to the hypothetical Watan, however, were not required to make any commitments regarding agricultural subsidies, even potential Amber-Box ones. The WTO Agreement on Agriculture, nonetheless, states that countries that did not make reduction commitments cannot subsequently implement trade-distorting subsidies in excess of 10% of the value of agricultural production in the relevant year. (WTO 1995) Should the Doha Round of WTO negotiations be concluded, Watan's situation regarding agriculture subsidies will not change, according to the latest draft of the Doha Round's modalities for a new agriculture agreement. (WTO 2008)

4.1 Traditional Deficiency Payment

A traditional deficiency payment (TDP) is an Amber-Box subsidy that simply remits to the farmer the monetary difference between the *FCP* and the actual price at which the farmer sold a

[12] There are also "Blue Box" subsidies which are similar to Amber Box ones, but where production levels are fixed. These are not relevant to our analysis.

relevant commodity to an unrelated party (recall that the model in this paper provides for transaction-by-transaction remuneration). The remittance would be issued by the Watan government during some "truing-up" period.

TDPs would be inefficient in a small country like Watan, and would produce serious perverse incentives. The scale issue is important for understanding potential agricultural market structure in micro states. Perverse incentives result from a TDP structure, including a lack of motivation to follow best practices.

4.1.1. Efficiency and the TDP System

A simple mathematical representation of the incentives the TDP illustrates the effects on efficiency. Let $\hat{C}_{mi}$ represent total economic costs under best practices for commodity m at farm i. For the representative best-practices farm, note that $\hat{C}_{mi} = FCP_m$. P_{mi} is the price received by farm i in the market, which may deviate from the equilibrium market price for standard goods produced under best practices, P_m. Define τ_{mi} to be a positive or negative deviation from $\hat{C}_{mi}$ for farm i. q_{mi} is defined to be a measure of additional unit innovation costs required for quality or product differentiation for farm i, and will be considered below. We assume the following function: $P_{mi}=F(\tau_{mi}, q_{mi})$.

The following relationships hold: If $\hat{C}_{mi}$ represents normal unit costs under best practices then if $\tau_{mi} > 0$ (implying waste), the market will not compensate standard, non-quality-enhancing costs above best practices through price premiums, as the quality of the goods will not exceed the norm:

$$\frac{\partial P_{mi}}{\partial \tau_{mi}} = 0 \qquad \text{for all } \tau_{mi} > 0. \tag{5}$$

But cost expenditure less than $\hat{C}_m$ will result in an inferior product, from economizing on quality control, proper handling, rigorous harvest schedules, etc. The market will reflect a sub-standard product through a discounted price:

$$\frac{\partial P_{mi}}{\partial \tau_{mi}} < 0 \qquad \text{for all } \tau_{mi} < 0. \tag{6}$$

Consider the economic-rent-possibilities formula facing an agricultural firm under a *TDP* system.[13] Rent is defined as:

$$\Pi_{mi} = \left(FCP_m - P_{mi}\right) + P_{mi} - \hat{C}_{mi} - \tau_{mi} - q_{mi} \tag{7}$$

[13] "Economic rent" is a return to capital in excess of opportunity cost.

Where the term in parentheses on the right hand side is the TDP. The farmer also receives the individual unit price, as set in the market. FCP_m and $\hat{C}_{mi}$ are fixed. Note that if $\tau_{mi} = 0$, $P_{mi} = P_m$ and $q_{mi} = 0$, $FCP_m = \hat{C}_{mi}$ and rents are zero.

The farm-specific price terms in (7) cancel and (7) can be written as:

$$\Pi_{mi} = FCP_m - \hat{C}_{mi} - \tau_{mi} - q_{mi} \qquad (8)$$

This implies that with respect to normal cost deviations from best practices:

$$\frac{\partial \Pi_{mi}}{\partial \tau_{mi}} = -1 < 0 \qquad \text{for all } \tau_m > 0\text{; and} \qquad (9)$$

$$\frac{\partial \Pi_{mi}}{\partial \tau_{mi}} = 1 > 0 \qquad \text{for all } \tau_m < 0 \qquad (10)$$

Whereas there are no incentives to allow non-quality-enhancing costs to exceed the best practices level, as they will not be compensated for in the market and will therefore produce returns lower than opportunity cost, rents can be gained by economizing on costs so that they are less than the best practices level. Skimping on quality control, handling, prompt delivery, etc. will result in profit above opportunity cost. This is because whatever discount occurs in the market due to inferior goods is made up by a higher TDP.

4.1.2. Quality and Product Differentiation in a TDP system.

In addition, under a TDP system there would be a lack of incentives to enhance quality or produce products differentiated by superior quality characteristics. Although still debated, many economists subscribe to the belief that differentiated products entail enhanced quality characteristics, and that competition in the quality-characteristic space benefits consumers. (Klein and Leffler 1981; Landes and Posner 1987) Quite a bit of empirical research on product differentiation has been conducted regarding the agricultural sector, and the results imply that quality-related product-differentiation, with associated price premiums, exist even for basic commodities. (Rosenbaum and Wilson 1991; Raboy and Simpson 1992; Wiggins and Raboy 1996).

Production of differentiated products in agriculture typically involves increased costs, but, absent distortions that interfere with market functioning, producers are compensated by price premiums in excess of these additional costs in the market (quasi-rents), which provide incentives to innovate. (Raboy and Wiggins 1997) A TDP mechanism applied on a transaction-by-transaction basis, however, eliminates incentives to compete in the quality-differentiation space because the farmer's TDP is limited to the difference between the *FCP*, a fixed amount, and the price the farmer receives in the market. The perverse result is that when a farmer enjoys a price premium in the market, it is negated by the lower TDP he/she will receive.

In normal circumstances, quality-enhancing investment costs yield price premiums:

$$\frac{\partial P_{mi}}{\partial q_{mi}} > 0 \qquad (11)$$

But with reference to equation (8), we see that under the TDP system:

$$\frac{\partial \Pi_{mi}}{\partial q_{mi}} = -1 < 0 \qquad \text{for all } q_{mi}. \qquad (12)$$

There is no incentive to strive for enhanced quality or produce differentiated products. Any premium price is negated by a lower *TDP*. At a normal zero-rent position, expenditure on quality-related investments will only serve to lower equity returns below opportunity cost.

4.2. Percentage Mark-up Deficit Payment Method

One way to substantially avoid the perverse incentives associated with a TDP system would be to calculate a percentage mark-up which would define the Deficit Payment as a Mark-Up Payment or MUP. The MUP would equal the product of the mark-up and the price actually received in the market for a given transaction. A pure mark-up system would also be an Amber-Box subsidy.

This type of system would require some preliminary calculations, but they are transparent. For ease of explanation we will consider only the initial calculation, understanding that periodic adjustments will be necessary. The first step would be to calculate the *FCP* for each commodity. Each *FCP* would then be compared to the periodic weighted-average price of competing imports in order to calculate a systematic percentage difference between the *FCP* and the indicative competitive market price, as represented by the average import price. These percentage mark-ups would be adopted for MUP purposes and would be fixed for each commodity, over a set period of time. The MUP would be calculated for each farmer on a transaction-by-transaction basis by multiplying the price the farmer actually received in the market by the fixed percentage mark-up.

The perverse incentives associated with the traditional deficiency payment likely do not exist when the Deficit Payment is defined as a percentage mark-up on received market price, or are certainly mitigated.

4.2.1. Efficiency in a MUP System

Consider the effects of a mark-up system on efficiency.

Defining M_m as the systematic mark-up for commodity m, the rent formula for the MUP system is:

$$\Pi_{mi} = (1 + M_m)P_{mi} - \widehat{C}_{mi} - \tau_{mi} - q_{mi} \tag{13}$$

Observe the effects of deviations from best-practices total costs. Referring to equations (5) and (6):

$$\frac{\partial \Pi_{mi}}{\partial \tau_{mi}} = -1 < 0 \quad \text{for all } \tau_{mi} > 0. \tag{14}$$

This is the same as with the TDP system. Rent can't be gained by incurring excess non-innovation costs (waste) above best-practices levels. But the incentives associated with cost structures below best practices are different:

$$\frac{\partial \Pi_{mi}}{\partial \tau_{mi}} = (1 + M_m)\frac{\partial P_{mi}}{\partial \tau_{mi}} + 1 \qquad \text{for all } \tau_{mi} < 0. \tag{15}$$

The partial derivative in the first right-hand-side term, from equation (6), is negative, but is multiplied by a number greater than 1, $(1+M_m)$. The rent seeking possibilities from cutting costs relative to best-practices levels are greatly diminished and, over a plausible range, would reduce profits below opportunity cost. Such cost cutting would only produce rents if the market does not sufficiently discount for substandard goods and the discount is less than cut costs by at least the amount $1/(1+M_m)$.

4.2.2. Quality and Product Differentiation in an MUP System

An innovative farmer would incur additional costs to produce agricultural products that are of enhanced quality, or are differentiated by desired characteristics, if such costs are more than made up by the price premiums the market is willing to pay for higher-quality goods. In the mark-up system, if the farmer can earn a price premium over the standard price in the market, then he has also increased his base for Deficit Payment purposes. The market premium associated with higher quality is thus magnified by application of the fixed mark-up to the higher price received by the farmer in the market.

The result for incurring costs associated with quality and product differentiation is as follows for the MUP system.

$$\frac{\partial \Pi_{mi}}{\partial q_{mi}} = (1 + M_m)\frac{\partial P_{mi}}{\partial q_{mi}} - 1 \qquad (16)$$

Normally, the increase in price associated with quality enhancement would have to exceed expenditure to produce quasi rents. The derivative on the right hand side would have to be greater than 1. But in the case of a MUP system the partial derivative in the first right-hand-side term no longer has to be greater than 1, because it is multiplied by ($1+M_m$). Indeed, if the mark-up percentage is 25% (the mark-up derived in the numerical example), the change in a farm's price in the market only has to rise a bit more than .8% for every 1% increase in quality-related expenditure. The MUP reinforces investment in quality-enhancement and product-differentiation expenditures which, under plausible scenarios, can produce quasi rents.

4.3 Hybrid Mark-up/Decoupled-Payment Method

An option that would employ Green-Box subsidies and minimize the use of Amber-Box subsidies would be a hybrid system. Under such a system a per-hectare decoupled income payment would be paid to the farmer in a set amount for each commodity. This payment would not vary with production. The decoupled payment could be supplemented by an MUP. Note that only the latter would be considered Amber-Box, and the system could be structured so that trade-distorting subsidies do not exceed the WTO-mandated 10% of production value.

The economic incentives of the hybrid system would be very similar to those associated with the pure mark-up system. A farmer incurs fixed costs that don't vary with production and variable costs that do. A decoupled income payment is equivalent to a fixed-cost subsidy, while the positive incentives toward product differentiation and quality enhancement would derive from the MUP.

5. A Numerical Example of the MSS—Corn

In this section a numerical example of the MSS is provided. The example considers a hypothetical, representative 100 hectare farm that produces only corn, abstracting from crop rotation. The illustration first shows the calculation of the *FCP* for corn from the hypothetical farm and then calculates a MUP under a percentage mark-up and a hybrid mark-up/decoupled payment system.

This example is for illustrative purposes only, and the actual quantitative result should not be perceived literally. The data for the example are derived from representative farms in countries with climatic conditions typical for the GCC, and were chosen to be as realistic as possible for farms employing best practices. Similarly, capital costs are derived from data in the region deemed representative. All costs are expressed in U.S. dollars.

5.1 The *FCP*

Data on operating costs for this hypothetical farm were primarily provided by the International Center for Agricultural Research in Dry Areas (ICARDA).[14] Table 1 displays assumed operating costs (variable and allocated fixed costs) on a per-hectare basis. **[Place Table 1 approximately here]**

The user cost of capital calculation, based on the expression in equation (3), begins with a delineation of required physical assets and their original cost.[15] Other required inputs are the economic depreciation rate for each physical asset and the appropriate rate of inflation.
Data for the economic depreciation rate, δ, for each asset category are based on the work of Hulten and Wykoff, (1981). We use the Qatari annual inflation rate in our example which over the 2000-2009 period averaged 6.18 percent. The WACC is calculated next, as it is used frequently in Middle East modeling. (Al Mutairi *et al* 2009) Our WACC computation is based primarily on data gathered from the State of Qatar.
In Middle Eastern countries the most popular source of debt financing is bank borrowing, while debt financing through issuance of debt securities is rather limited. (IMF, 2009) We assume that the investor receives debt financing, and that a cost of debt of 5.25 %, which is the yield on a recent 10-year sovereign bond issued by the State of Qatar, is a plausible approximation of bank-borrowing interest rates.

CAPM is used to calculate the equity hurdle rate relevant to potential investors in the Watan corn farm. Various studies considered evidence on CAPM betas in agriculture. (Erickson *et al* 2001; Turvey and Driver 1987; Hopkins and Morehart 2002)

[14] Operating cost data were based primarily on farms in Syria and were transmitted by Aden Aw-Hassan and Ahmad Maziz, ICARDA, Aleppo, Syria.

[15] These data were provided by Aden Aw-Hassan, ICARDA, Aleppo, Syria.

CAPM is estimated using realized excess returns, as follows:

$$i_E - i_F = \alpha + \beta(i_M - i_F) + \varepsilon \qquad (17)$$

α, the intercept, should not be statistically different from zero (because the market premium should compensate for systemic risk) and β is interpreted in the standard fashion.

Equation (17) is estimated as follows, incorporating two caveats: Benjelloun and Squalli (2008) have demonstrated that in the emerging capital markets of the GCC, general stock indexes often poorly reflect individual-sector performance. As will be seen, however, robust results are obtained for Qatar. Market-returns data are obtained from the Qatar Exchange (QE) for month-end equity market index values of the Qatar Index. Benjelloun (2009) has shown that in certain GCC stock markets diversification can be achieved with only a few stocks in a portfolio, systemic risk is high and index and stock returns are highly correlated. With this caveat, our proxy asset-specific return is the rate of return on a relatively risky stock—Commercial Bank of Qatar (CBQK).

The risk-free return is derived from 10-year U.S. government bond yields with average annualized monthly yields obtained from *International Financial Statistics*, published by the International Monetary Fund. Asset-specific excess returns are regressed on market excess returns using ordinary least squares (OLS) and also alternative robust-estimation procedures. These include the Median estimator, least trimmed squares (LTS) (Rousseeuw 1984), Huber's (1964) M-estimators, and the MM-estimators proposed by Yohai (1987).

OLS has problems when observations with very large residuals distort parameter estimation due to outliers. (Verardi and Croux 2009) The basic measure of the robustness of an estimator is its "breakdown point," which is the fraction of "bad" data that can be tolerated without affecting the estimator to an arbitrarily large extent. The M-estimator and Rousseeuw's LTS estimator are highly inefficient in that high efficiency can only be achieved at the cost of lower breakdown points. MM-estimators combine a high breakdown point with high efficiency.

We consider two versions of this estimator: MM-estimators with 70% efficiency and with 95% efficiency. Simulation results by Verardi and Croux (2009) show that the MM-estimator with an efficiency of 70% is the least biased estimator, and results produced by this method are the ones reported in this paper.

The sample period is January 2000 to December 2009. The regression results for Equation (17) are as follows (standard errors are in parenthesis):

$$i_E - i_F = \underset{(0.855)}{0.186} + \underset{(0.054)}{1.226} \times (i_M - i_F)$$

Robust $R^2 = 0.894$

β is estimated at 1.226 and is statistically significant at the 1% level. The coefficient of the intercept is not significantly different from zero.

Over the 2000-2009 sample period the average annualized market rate of return was 25.58%, while during the same period the average annualized risk-free return was 4.45%, indicating a market risk premium of 21.07%. The asset-specific (CBQK) risk premium, the product of CAPM β and the market risk premium, is 25.83%.

Debt/equity mixes in a nascent Arab micro state agricultural sector will be a function of contracting practices, potential governmental loan guarantees, and the MSS. We assume, for illustrative purposes, that agricultural investments enjoy long term take-and-pay contracts and loan guarantees—facilitating low-cost interest rates and high proportions of debt. The debt/equity ratio is set at 70/30. Therefore, the WACC is 11.42%. Table 2 displays for each physical asset total-farm original asset costs, the economic depreciation rate, and the calculated user cost of capital. **[Place Table 2 approximately here]**

Yield estimates for corn cultivation in arid climates for good farms vary widely. For example De Pauw (2010) uses a range of 4 to 6 tonnes/hectare, but also refers to a research result of 9 tonnes/hectare. Data from functioning farms in UAE have shown yields of 12 tonnes/hectare, but this seems too high for a meaningful demonstration. (UAE 2006) For purposes of this illustration we assume a yield of 6 tonnes/hectare.

The result produced by summing per-hectare costs and dividing by yield is the *FCP* of producing a tonne of corn on the hypothetical 100 hectare Watan farm. As depicted in Table 3, the calculated *FCP* per tonne for corn is \$387. **[Place Table 3 approximately here]**

5.2 The Deficit Payment--Two Options

Should the market price, determined by import prices of corn, be lower than the full economic cost of domestic production as depicted in Table 3 (and eliminating as a candidate the TDP), a MUP of some sort (or another mechanism not discussed in this paper) will be required to ensure that farming remains financially sustainable to private investors. This section will provide numerical examples for two options—a stand-alone MUP and an MUP/decoupled-payment system. The data required for the examples are displayed in Table 4. The economic cost of domestically produced corn from our hypothetical Watan farm is compared to the weighted average price of imported corn over 2007 and 2008, which is employed to represent a single market transaction price.[16] As illustrated, the weighted-average import price is $311/tonne and the deficit is $76/tonne. Selected individual shipment prices are also displayed for comparison purposes.[17] **[Place Table 4 approximately here]**

5.2.1. A Pure MUP System

First consider a pure percentage mark-up system. Recent import data would be compared to the constructed cost in the *FCP* model for each commodity—to produce the percentage mark-up. When a farmer sold his goods he would be eligible for the amount he actually received in the market, plus an MUP equal to the product of the mark-up and his actual market price.
In our example, the calculated deficit is $76/tonne, 24.4% of the weighted-average import price for corn of $311/tonne. Under the MUP system the authorities could set the deficit mark-up at, say, 25%. If a farmer gained in the market a price exactly equal to $311/tonne, he would receive a MUP of $77.75/tonne. If the farmer produced an inferior product that sold at a discount in the market, say $290/tonne, his MUP would be $72.50/tonne for total remuneration of $362.50/tonne. Unless the farmer could reduce costs by more than the FCP less total payment, which is unlikely, compensation would be less than economic cost and insufficient to remit the opportunity cost of capital. If he sold a superior, differentiated product at a premium price on the market, say $350/tonne, his MUP would be $87.50/tonne for total remuneration of $437.50/tonne—which would likely include economic rents.

If a farmer's costs were higher than the FCP's best-practices model costs, he would suffer low returns. For example a farmer with total economic costs of $400/tonne, but producing corn of

[16] Representative import data is based on monthly corn import prices in Qatar as provided by the Qatar Statistics Authority (2009).

[17] These values were derived from micro-data produced by Qatar Customs and Ports Authority.

average quality would still receive $311/tonne in the market. With the MUP his total remuneration would be $388.75/tonne, $11.25/tonne less than total economic costs. This loss would come directly out of equity returns.

A pure MUP system has a lot to recommend it. Quality enhancement and differentiated products are rewarded. There is, however, a major draw-back. The MUP system is an Amber Box subsidy under WTO definitions. A pure MUP system would put Watan in a position of implementing trade-distorting subsidies in excess of the 10% *de minimus* level. Using corn as an example, by definition the level of subsidy would be approximately 25% of the value of agricultural production, as represented by actual market prices.

5.2.2. A Hybrid System

There are alternatives that would ensure that farming is remunerative and would maintain the positive incentives of the percentage mark-up system, but would keep Amber-Box subsidies below the 10% threshold. A hybrid system including a decoupled income payment and a MUP has potential to produce the desired incentives without running afoul of WTO agreements. Consider the following possibility. From the data in Table 3 it can be calculated that variable costs are 30.51% of total economic cost/tonne of corn, or $118.17. Allocated fixed costs are $11.17/tonne, or 2.88% of unit cost. Capital costs are about 66.61% of unit cost; $258. A hybrid system could be designed to pay, say, a $270/hectare decoupled income-support payment. This payment would not be linked to production, is Green Box, and would only be offered to active corn farms. The total decoupled support would be solely a function of the size of the farm. For a farm with a yield of 6 tonnes/hectare, the decoupled payment is economically equivalent to about a $45/tonne subsidy of fixed and capital costs. On top of this is added a percentage MUP of 10% of the price the farmer actually receives in the market. Assuming an average market price of $311/tonne, the MUP will be about $31/tonne. The sum of the market price, the pro-rated decoupled income payment and the Deficit Payment is $387/tonne, exactly equal *FCP* for the representative farm.

Under this hybrid system, the positive incentives of the mark-up system are maintained, if somewhat diminished, but total Amber-Box support is approximately 10%, the threshold level for trade-distorting subsidies established in the *Agreement on Agriculture*.

There is any number of combinations of systems that would achieve the same qualitative result. This illustration shows that it is possible to construct a MSS for a hypothetical country like Watan that is WTO-compliant, minimizes perverse incentives and enhances positive ones, and is capable of ensuring financial sustainability for investors of all sorts in the Qatari agricultural sector.

6. Discussion and Future Research

This paper has derived a conceptual model for a Market Stabilization System (MSS) appropriate for agriculture in Arab micro states. The components of the model were 1) a Full Cost Price (*FCP*) that accounted for all variable and fixed costs and the opportunity cost of capital for a unit of production of an agricultural commodity; and 2) a Deficit Payment that made up the difference between the *FCP* and the price a farmer received in the market for a specific transaction. The paper analyzed several options for a Deficit Payment and concluded that the one that displayed the most desirable characteristics was one where the farmer received a percentage mark-up on the price received in the market for a specific sale. The mark-up would be set to be the percentage difference between the *FCP* and the frequently-adjusted weighted-average import price for each commodity. The deficit payment would be calculated on a transaction-by-transaction basis—made possible by the small scale of the target countries; Arab micro states. The transactions-based system is key to maximization of a desirable incentive structure.

The Deficit Payment structure described makes best use of market signals, punishes inefficiency, and rewards quality enhancement and product differentiation. It has been designed to be compliant with the WTO *Agreement on Agriculture*.

The model was designed for micro states with emerging or embryonic agricultural sectors. But it is also appropriate for countries which desire to enhance their existing agricultural sectors by better aligning production and market incentives. Food-security concerns make both scenarios likely.

This paper has only presented a conceptual model for a Market Stabilization System for Arab micro states. Much additional research remains to be done prior to serious consideration of implementation.

Any domestic support system contains the seeds for fraudulently gaming the system. It is beyond the scope of this paper to address fraud and audit issues, but anti-fraud measures should rank high on the list of future research topics. Two potential sources of fraud initially come to mind: 1) origin fraud; and 2) collusion between buyer and seller to fraudulently overstate invoice price.

Additional research must be conducted on the incentive effects of various alternative Deficit-Payment formats. This paper has just scratched the surface by discussing a few options.
This paper provided a simple numerical example of the functioning of a potential Market Stabilization System for agriculture in a hypothetical Arab micro state. If the system is to become operational in any particular country, substantial research must be devoted to optimizing data sources for each affected commodity, in order to produce *FC*Ps that are precise representations of full economic costs.

Finally this paper did not address the administration of a MSS. All of the institutional details, and day-to-day administrative functions, must be delineated in future research.

References

Agricultural & Applied Economics Association (AAEA), 2000. *Commodity Costs and Returns Estimation Handbook*, Ames, Iowa.

Al-Nasser, a., 2006. Regional Report: Poultry industry in Kuwait. *World's Poultry Science Journal,* 62, 702-708.

Al Mutairi, M. E., Tian, G., Tan, A., 2009. Corporate finance practice in Kuwait: a survey to confront theory with practice. Paper presented to the 22nd Australasian Finance and Banking Conference 2009. Available at http://ssrn.com/abstract=1456750.

Benjelloun, H., 2009. Portfolio diversification: evidence from Qatar and the UAE. *Int. J.Econ. Iss.*, 2, 9-15.

Benjelloun, H., Squalli, J., 2008. Do general indexes mask sectoral inefficiencies? A multiple variance ratio assessment of Middle Eastern equity markets. *Int. J. Man. Fin.*, 4, 136-151.

Bjornson, B., Innes, R., 1992. Another look at returns to agriculture and nonagricultural assets, *Am. J. Agric. Econ.*, 74, 109-119.

De Pauw, E., 2010. Land survey for suitability and availability for food and feed production in Qatar. *The Agricultural Sector in Qatar: Challenges and Opportunities*, International Center for Agricultural Research in Dry Areas (ICARDA), Aleppo, Syria.

Erickson, K.W., Mishra, A.M., Moss, C.B., 2001. Rates of return in the farm and non-farm sectors: a time series comparison. Paper presented to the 2001 Annual Meeting of Western Agricultural Economics Association, July 8-11, Utah.

Food and Agricultural Organization (FAO) 2010. Country profile: food security indicators—Kuwait. FAO Rome.

Fullerton, D., 1987. The indexation of interest, depreciation and tax reform in the United States. *J. Pub. Econ.*, 32, 25-51.

Hall, R., Jorgenson, D., 1967. Tax policy and investment behavior. *Am. Econ. Rev.*, 57, 391-414.

Hopkins, J.W., Morehart M., 2002. An empirical analysis of the farm problem: comparability in rates of return, in Luther Tweeten and Stanley R. Thompson-eds. *Agricultural Policy for 21st Century* Iowa State Press, Iowa, 70-90.

Huber, P.J., 1964. Robust estimation of a location parameter, *Annals of Mathematical Statistics*, 35, 73–101.

Hulten, C.R., Wykoff, F.C., 1981. The measurement of economic depreciation, in C.R. Hulten-ed., *Depreciation, Inflation, and the Taxation of Income from Capital*, Urban Institute Press, Washington DC, 81-125.

IMF, 2009. *Global Financial Stability Report*, International Monetary Fund, October, Washington DC.

Jorgenson, D., 1963. Capital theory and investment behavior, *Am. Econ. Rev.*, 53, 247-259.

Klein, B., Leffler, K., 1981. The role of market forces in assuring contractual performance, *J. Pol. Econ.*, 89, 615-641.

Lagerkvist, C., 1999. The user cost of capital in Danish and Swedish agriculture, *Eur. Rev. Ag. Econ.*, 26, 79-100.

Landes, W.M., Posner, R.A., 1987. Trademark law: an economic perspective, *J. Law Econ.*, 30, 265-309.

Lewis, P.E.T., Hall, N.H., Savage, C.R., Kingston, A.G., 1988. Taxation, cost of capital and investment in Australian agriculture, *Aust. J. Agric. Econ.*, 32, 15-21.

Lintner, J., 1964. The valuation of risky assets and the selection of risky investments in stock portfolios and capital budgets, *Rev. Econ. Stat.*, 47, 13-37.

Mazid, A. Aw-Hassan, A., 2010. Report on cost production costs in Qatar, *The Agricultural Sector in Qatar: Challenges and Opportunities*, International Center for Agricultural Research in Dry Areas (ICARDA), Aleppo, Syria, 413-424.

Narrod, C., Roy, D., Okello, J., Avendãno, B., Rich, K., Thorat, A., 2009. Public-private partnerships and collective action in high value fruit and vegetable supply chains, *Food Policy*, 34, 8-15.

Qatar National Food Security Programme (QNFSP) 2012. http://www.qnfsp.gov.qa/

Qatar Statistics Authority (2009): Monthly HS 8-digit data for 2004-2006 provided electronically.

Raboy, D.G., Simpson, T., 1992. A methodology for tariffication of commodity trade in the presence of quality differences—the case of peanuts, *World Econ.*, 15, 271-281.

Raboy, D.G., Wiggins S.N., 1997. Intangible capital, hedonic pricing and international transfer prices, *Pub. Fin. Rev.*, 25, 347-365.

Rich, K.M., Narrod, C.A., 2010. The role of public-private partnerships in promoting smallholder access to livestock markets in developing countries, Discussion Paper 01001, International Food Policy Research Institute, Washington DC.

Rosenbaum, R.E., Wilson W.W., 1991. Quality differentials and prices: are cherries lemons?, *J. Ind. Econ.*, 34, 649-658.

Rousseeuw, P.J., 1984. Least median of squares regression, *J. Am. Stat. Assoc.*, 79, 871–880.

Sharpe, W.F., 1964. Capital asset prices: a theory of market equilibrium under conditions of risk, *J. Fin.*, 19, 425-442.

Streeten, P., 1993. The special problems of small countries, *World Dev.*, 21, 197-202.

Turvey, C.G., Driver, H.C., 1987. Systematic and nonsystematic risks in agriculture," *Can. J. Agric. Econ.*, 35, 387-401.

United Arab Emirates (UAE), Ministry of Economy, 2006. *Statistical Abstract*, Accessed in February 2010. http://www.economy.ae/English/EconomicAndStatisticReports/StatisticReports/StatisticAbstract/Pages/sa2006.aspx .

United Arab Emirates (UAE), National Bureau of Statistics. Accessed in May 2012. http://www.uaestatistics.gov.ae

USDA-Economic Research Service, 2009: "Commodity Costs and Returns," at http://www.ers.usda.gov/Data/CostsAndReturns/, Washington DC.

USDA-Foreign Agricultural Service (USDA-FAS) 2006. Kuwait poultry products annual poultry meat report 2006. GAIN Report KU6002. United States Department of Agriculture, Washington DC,

Verardi, V., Croux C., 2009. Robust regression in stata, *Stata J.*, 9, 439-453.

Wiggins, S., Raboy, D.G., 1996. Price premia to name brands: an empirical analysis, *J. Ind. Econ.*, 44, 377-388.

Williamson, O., 1975. *Markets and Hierarchies,* Free Press, New York, NY.

World Bank 2009. *Improving Food Security in Arab Countries*. World Bank. Washington DC.

World Trade Organization, 1995. *Agreement on Agriculture*, Geneva, CH.

World Trade Organization, Committee on Agriculture, 2008. *Revised Draft Modalities for Agriculture*, TN/AG/W/4/Rev. 4, December, Geneva, CH.

Table 1: Corn Farm Operating Costs (100 hectare farm)

		Total Farm	Per hectare
Variable Costs	Tillage and Leveling		$98
	Seed		$18
	Fertilizer and other chemicals		$97
	Water		$76
	Maintenance		$57
	Labor		$235
	Harvesting and Transport		$95
	Packing materials		$33
Allocated Fixed Costs	Marketing Costs	$300	$3
	Computer Services	$100	$1
	Accounting Costs	$900	$9
	Management Overhead	$2,600	$26
	General Farm Overhead	$1,700	$17
	Other Farm Overhead	$1,100	$11

Source: Data from ICARDA, provided by Aden Aw-Hassan and Ahmad Maziz.

Table 2: Machinery Requirements, Unit Prices, Economic Depreciation and User Cost of Capital for a Representative Arid-Climate 100 Hectare Corn Farm

Machinery	Number	Unit price (US$)	Economic Depreciation	User cost of capital
Tractor FEL (Small)	1	$60,000	0.1633	$12,942.00
Tractor (Medium)	1	$90,000	0.1633	$19,413.00
Planter 4 m	1	$65,000	0.0971	$9,717.50
Irrigation boom & sprinkler	1	$85,000	0.0971	$12,707.50
Irrigation pipe network & pump	10km	$45,000	0.0971	$6,727.50
Plough (Moouldboard)	1	$25,000	0.0971	$3,737.50
Cultivator 15 tyne (Duck foot)	1	$25,000	0.0971	$3,737.50
Boomsprayer 12m 2000l	1	$40,000	0.0971	$5,980.00
Fertilizer spreader 20m	1	$40,000	0.0971	$5,980.00
Combine harvestor (4m)	1	$250,000	0.0971	$37,375.00
Grain handling equipment	1	$8,000	0.0971	$1,196.00
Grain storage (40 tonne)	1	$10,000	0.1225	$1,749.00
Machinery shed (30m ´ 10m)	1	$20,000	0.1225	$3,498.00
Machinery workshop/store	1	$25,000	0.1225	$4,372.50
Truck (5 tonne)	1	$55,000	0.2537	$16,835.50
Pickup vehicle	1	$22,000	0.3333	$8,485.40
Computers	1	$1,500	0.2729	$487.95
TOTALS for 100 hectares		**$866,500**		**$154,942**
Per hectare costs		$8,665		$1,549

Source: Original cost data from ICARDA, provided by Aden Aw-Hassan. Economic depreciation rates from Hulten and Wykoff (1981)

Table 3: Economic Cost of Corn Per Tonne

		Total Farm	Per hectare
Variable Costs	Tillage and Leveling		$98
	Seed		$18
	Fertilizer and other chemicals		$97
	Water		$76
	Maintenance		$57
	Labor		$235
	Harvesting and Transport		$95
	Packing materials		$33
Allocated Overheads	Marketing Costs	$300	$3
	Computer Services	$100	$1
	Accounting Costs	$900	$9
	Management Overhead	$2,600	$26
	General Farm Overhead	$1,700	$17
	Other Farm Overhead	$1,100	$11
User Cost of Capital	Tractor FEL (Small)	$12,942.00	$129
	Tractor (Medium)	$19,413.00	$194
	Planter 4 m	$9,717.50	$97
	Irrigation boom & sprinkler	$12,707.50	$127
	Irrigation pipe network & pump	$6,727.50	$67
	Plough (Moouldboard)	$3,737.50	$37
	Cultivator 15 tyne (Duck foot)	$3,737.50	$37
	Boomsprayer 12m 2000l	$5,980.00	$60
	Fertilizer spreader 20m	$5,980.00	$60
	Combine harvestor (4m)	$37,375.00	$374
	Grain handling equipment	$1,196.00	$12
	Grain storage (40 tonne)	$1,749.00	$17
	Machinery shed (30m ´ 10m)	$3,498.00	$35
	Machinery workshop/store (30m ´ 10m)	$4,372.50	$44
	Truck (5 tonne)	$16,835.50	$168
	Pickup vehicle	$8,485.40	$85
	Computers	$487.95	$5
		TOTAL Per HECTARE=	$2,324
		YIELD Per HECTARE (tonnes)=	6
		Economic Cost Per Tonne=	**$387**

Source: calculations from Tables 1 and 2. Yield data from DePauw (2010)

Table 4: Calculation of Deficit Payment

Economic Cost/Tonne of Corn From Hypothetical Watan Farm	$387
2007/2008 Weighted Average Import Price in Qatar	$311
Excess Domestic Cost Over Import-Price Determined Market Price	$76

Sample Shipment Prices-Doha Port Arrivals

DATE	ORIGIN	C.I.F. PRICE/TONNE
10-Feb-07	Argentina	$293
19-May-07	Argentina	$293
1-Jul-07	Argentina	$293
29-Jul-07	Argentina	$293
17-Sep-07	Argentina	$292
1-Nov-07	US	$339
17-Dec-07	US	$351

Source: Data from Qatar Statistics Authority (2009) and micro-data from the Customs and Ports Authority of the State of Qatar.