Landscape Clubs: Co-existence of GM and Organic Crops

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Abstract

The possibility of increased production of genetically modified (GM) crops in agriculture accentuates the need to examine the feasibility of GM and non-GM technologies coexisting on a common physical landscape. Using the theory of clubs, this paper examines the possibility of co-existence for GM and organic wheat technologies through the formation of an organic club with an endogenously determined buffer zone. Given the available data on prices, yields, and rotations, it is shown that a club can be created in which GM and organic agricultural production technologies can economically co-exist in the same physical landscape. Specifically, co-existence results in an increase in economic welfare over a situation where only GM technology is used but is not Pareto superior because producers in the buffer zone will incur injury. We show that organic producers in the club can compensate producers in the buffer zone and still be better off. Hence, the compensation principle holds.

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[1] Senior authorship is not assigned.

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Introduction

Over the past decade, organic agriculture has emerged as a profitable form of farming in North America and Europe. The rapid growth in demand for organic products has shifted organic agriculture from a cottage industry to a significant segment of the agricultural mainstream. Retail sales of organic products in both North America and Europe are estimated to be increasing by 20-25% annually, and were valued at approximately 9.5 billion and 10 billion dollars in the two regions, respectively, in the year 2000 (Verschuur and van Well, 2001). In 2003, there were approximately 10,000 organic farmers in North America, and acreage was estimated to be 3.3 million acres (Yussefi, 2003).[2]

Organic crop production prohibits the use of some modern inputs including synthetic pesticides, fertilizers, and genetically engineered seeds (often referred to as genetically modified organisms or GMOs).[3] Products can only be labelled "certified organic" if all procedures occurring along the supply chain (from crop production to processing) have been verified to comply with established organic standards. Producers of most "certified organic" products are able to obtain a price premium over conventional products of similar type and quality.[4]

To obtain "certified organic" status at the farm level, a crop must be 100 percent free of GMOs, which implies that any chemical test of the organic product would be negative for the presence of a GMO in the sample being tested. This requirement raises the issue of whether organic production of an open pollinated field crop, such as wheat or canola, can share a common

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[2] The major organic crops are wheat, corn, soybeans, flax, lentils, peas, forages, and horticulture crops.
[3] GMO refers to any plant that has recombinant DNA; that is, where DNA has been extracted from one organism and recombined with the DNA of another.
[4] To obtain premiums over conventional crops, organic commodities must be segregated from conventional commodities as they move along the supply chain. Compliance with organic standards (including segregation) is ensured through audit trails. These audits allow buyers at each successive stage of the supply chain to determine the origin of individual products. In cases where crops are exported, regulators in importing countries typically verify organic authenticity through a variety of procedures including an evaluation of the standards employed by the exporter, an inspection of audit trails, and through testing for

landscape with varieties of the same crops that are produced using GM technologies. In Canada, for example, farmers who produce organic canola claim that the presence of GM canola varieties, and the occurrence of genetic drift, makes it impossible for them to have their organically produced canola certified as organic. They are currently in the process of suing Monsanto and Aventis for losses resulting from their inability to market their canola organically (Hamm et al. 2002). Such impurities have been known to arise through the mixing of crops during or after harvest (e.g. in combines, granaries, other equipment, etc.), and through the growth of volunteer crops in subsequent years.

The issue described above is also being raised in the European Union (EU), where GM crop production, and its impact on organic and conventional production, has taken on significant debate (Villalon, 2002). As is the case in Canada, this debate is contingent upon whether or not different production technologies can exist in the same landscape. However, given the close proximity of European countries, the debate in the EU pertains to the ability of producers to maintain GM free crop zones on a regional or even a national basis.

One possible solution to the problem described above is for organic producers to form a landscape club (with a buffer zone) in which only organic production can occur. Although rare in agriculture, the formation of clubs is a common mechanism through which a group of individuals derive collective benefits or deal with external threats to potential club members[5]. In this case, a club would allow organic producers to farm in an area that is free from the risk of GM contamination, and would allow producers outside the area to farm using GM technology. Under these circumstances, it may be possible for organic producers to experience an increase in economic welfare without decreasing the welfare of GM producers.

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the presence of banned substances, including GMO's. Contamination of a shipment with banned substances will result in rejection of the shipment, ultimately at the expense of the organic farmer.

[5]For example, the North Atlantic Treaty Organization (NATO) was a club of nations formed to deter the Soviet threat to Western Europe.

The objective of this paper is to examine the economic feasibility of organic and GM wheat technologies co-existing in the same landscape. We hypothesize that the co-existence of GM and organic technologies can result in an increase in the total economic welfare of producers over the situation where only one technology is employed.[6] Using a simple economic model and actual data from Saskatchewan[7] organic wheat farmers, we show that given existing premiums, organic wheat producers could form a landscape club, pay the costs associated with operating the club, and still increase their economic welfare.[8] This paper does not investigate potential institutional or logistical implications associated with forming such a club. Rather, we examine the economic feasibility of club formation and discuss institutional arrangements in the historical context of club formation.

The paper is organized into six sections. Section two provides and overview of club theory and describes how the theory of clubs can be used as a framework to examine the co-existence of crop production technology. The third section describes the theoretical model, while the fourth section discusses the empirical model and results. The fifth and sixth sections of the paper are institutional implications and conclusions, respectively.

Club Theory

Modern club theory, first introduced by Buchanan in 1965, evolved out of literature on the formation of groups. Buchanan suggested that agents form groups to share the cost of excludable public goods and in the process confer externalities upon each other (Scotchmer, 2002). Taking this notion further, Sandler and Tschirhart (1997) suggest that club theory is based upon two basic premises. First, the presence of crowding requires the size of a club to be

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[6] The premise of co-existence arose because some consumers have concerns regarding the safety of GM products. This paper does not address this issue.
[7] The preferred jurisdiction to study is Canada; however, data on organic wheat production was only available for Saskatchewan.
[8] The existence of a price premium for organic wheat over conventionally produced wheat is reported in Hamm (2002).

restricted. That is, as club size increases, it begins to function less efficiently, and eventually reaches the point where the costs of maintaining the club are greater than the benefits it confers. The second premise is that the membership size of the club and the provision of club goods are interdependent allocation decisions (Sandler and Tschirhart, p. 336).

In addition to the two premises above, Sandler and Tschirhart (1997) identify four characteristics of club goods that distinguish them from public goods. First, clubs must be privately owned but are voluntary in terms of membership. Second, all non-members of a club must be completely excluded from the benefits of membership. Third, there can be no overlap of a club's membership (i.e. members cannot be both inside and outside of the club). Finally, there must be an institutional arrangement to monitor club members, to collect fees, and to keep non-members outside of the club. In the case of an organic club modeled in this paper, all six of the characteristics described here are assumed to exist.

As an economic tool, club theory has been used to examine the incentives for club formation and the conditions under which clubs can feasibly exist. It has been applied to a wide range of issues most notably the break-ups and formations of jurisdictions (Bolton and Roland 1987), the optimal use of land for urban planning (Dixit, 1973) and the optimal construction of road ways in urban centers (Solow and Vickery, 1971). In recent years, jurisdictional applications of club theory have incorporated spatial components to the formation of clubs (Casella, 2001).

In our case, a club is defined on a physical agricultural landscape, and is formed in response to the commercialization of GM wheat. The club forms to protect its members from a possible negative externality, namely contamination with GM wheat. Within the proposed club, all crop production is organic (i.e. it is an organic producers club), while outside the club, farmers will use GM crop technologies[9]. As with traditional club theory, the size of our club is restricted by the problem of crowding. Crowding occurs because only a certain acreage of cropland can be

[9] Producers can produce organic crops outside the club boundary; however, rationally they would not do so because their crops would likely become contaminated.

used to produce organic wheat before the price becomes too low to cover production costs. That is, as the size of the organic club increases, the supply of organic wheat increases, which in turn reduces the price that buyers of organic wheat, are willing to pay.

Theoretical Model

We define a club as an institution whose members collectively decide to finance the creation of an excludable club good through a tax. In our case, the excludable club good is an organic premium that can be earned by selling organic crops. The premium can only be obtained by implementing a zoning law that restricts the use of GM seed varieties. Inside the boundary of the club, producers will produce exclusively organic crops, while outside the boundary; producers will produce GM crops. To illustrate how the club size is determined we initially assume that a buffer zone is not required; however in subsequent discussion, we do incorporate a buffer zone.

Returning to our original hypothesis, the question becomes "can organic producers generate an increase in total producer welfare by implementing a zoning law that exclusively allows organic production to occur within a confined geographical space?" That is, by forming a club, can organic producers earn enough organic premium to improve overall producer welfare, once the additional costs of the club and the costs of establishing and enforcing the zoning law are included?

Figure 1 presents the situation without a buffer zone, or alternatively, the situation where contamination can be eliminated completely and costlessly. The horizontal axis is the total output that can be obtained if all available farm land is used for wheat production. As can be seen in Figure 1, GM producers face a flat demand curve D_{GM}, while organic producers face a downward sloping demand curve D_0. The reason for this is that GM producers are assumed to be price takers for wheat, while organic producers are assumed to be able to influence wheat price by increasing or decreasing supply. Our model further assumes that producers are risk neutral regardless of the production technology they choose.

The objective function of the organic club is to maximize profits given the demand (average revenue) function for wheat. We assume that land is homogenous and that the land market is perfectly competitive. Hence, the profit function for the organic club can be written as:[10]

$$\prod_o = P_o\ [Q_o(L_o)] * Q_o(L_o) - r * L_o \quad ---1.0$$

where, P_o is the organic wheat price, $Q_o(L_o)$ is the production function for organic wheat, r is the rental rate for land and L_o is the land that is used for organic wheat production.

Similarly, the profit function of GM wheat producers can be written as:

$$\prod_G = P_G * Q_G(L_G) - r * L_G \quad ---2.0$$

where P_G is the GM wheat price, $Q_G(L_G)$ is the production function for GM wheat, r is the rental rate for land and L_G is the land that is used for GM wheat production. It is assumed that all land area (L_T) is used either in the production of organic wheat or GM wheat. This is secured by the constraint:

$$L_T = L_o + L_G \quad ---3.0$$

The total profit equation, after substituting the land constraint, can be written as:

$$\prod_T = \prod_o + \prod_G = P_o\ [Q_o(L_o)] * Q_o(L_o) - r * L_o + P_G * Q_G(L_T - L_o) - r * (L_T - L_o) \quad ---4.0$$

[10] If organic wheat producers form a club they would be able to operate as a monopolist. We assume they operate as such in the rest of this analysis.

The solution of the joint profit maximization problem yields:

$$\partial \prod_T / \partial L_o = [\ P_o + (\partial P_o / \partial Q_o)\ ]\ (\partial Q_o / \partial L_o) - r + P_G\ (\partial Q_G / \partial L_G) + r = 0 \quad \text{---5.0}$$

The solution can be re-organized to obtain:

$$P_o\ [\ 1 - 1 / \mid \varepsilon_o \mid\ ]\ (\partial Q_o / \partial L_o) = P_G\ (\partial Q_G / \partial L_G) \quad \text{---6.0}$$

The first order condition (FOC) for the profit maximization problem has a solution where the marginal revenue product of the organic producers will be equal to value of marginal product of GM producers (i.e. $MR_o * MP_{Lo} = P_G * MP_{LG}$). If the marginal productivity of land in both organic and GM production is the same ($MP_{Lo} = MP_{LG}$), the FOC requires that the marginal revenue of organic farming will be at least equal to the price of GM wheat i.e. $P_G = MR_o$. However, the marginal productivity of land in organic farming is lower than that of GM farming, thus yielding a higher marginal cost curve, as shown in Figure 1 (i.e. $MP_{Lo} < MP_{LG}$). Hence, marginal revenue obtained by the organic producers must be greater than the price that is obtained by the GM producers (i.e. $P_G < MR_o$) . For this to occur, organic producers must receive a premium over the price of GM wheat that depends on the elasticity of demand for organic wheat. Equation 7.0 reveals that the lower the elasticity of demand for organic products, the higher will be the price premium of organic wheat over GM wheat.

$$P_o / P_G > 1 / [\ 1 - 1 / \mid \varepsilon_o \mid\ ] \quad \text{---7.0}$$

If a buffer zone is created, producers in the buffer zone will have lower productivity as they will be subject to restrictions the organic producers have (resulting in higher costs of wheat production), but they will receive the lower conventional wheat price. In this case, producers in the buffer zone will have to be compensated by the organic club an amount that makes them indifferent between being in the buffer zone and being outside the buffer zone. The profit equation of the organic club in this case can be written as:

$$\prod_C = P_o [Q_o(L_o)] * Q_o(L_o) - r * L_o - \{P_o [Q_o(L_o)] - P_G \} Q_B(L_B) - r * L_B \text{ ---8.0}$$

where L_B is the land reserved for the buffer zone. L_B is assumed to be related to the size of the organic land area as follows $L_B = \alpha L_o$ where α is the ratio of the area of land in the buffer zone to the area of land in the club.

The overall profit equation in this case can be written as:

$$\prod_T = P_o [Q_o(L_o)] * \{Q_o(L_o) - Q_B(L_B)\} - r * (L_o + L_B) + P_G * Q_G(L_T - (L_o + L_B)) - r * (L_T - (L_o + L_B)) \text{ ---9.0}$$

The first order condition for the maximization problem above can be obtained as:

$$\partial \prod_T / \partial L_o = (\partial P_o / \partial Q_o) * (\partial Q_o / \partial L_o) \{Q_o(L_o) - Q_B(L_B) \}$$
$$+ P_o * \{ (\partial Q_o / \partial L_o) - \alpha (\partial Q_B / \partial L_B) \} - r (1 + \alpha)$$
$$- (1 + \alpha) * P_G (\partial Q_G / \partial L_G) + r (1 + \alpha) = 0 \text{ ---10.0}$$

Assuming $\partial Q_o / \partial L_o$ equals $\partial Q_B / \partial L_B$, rearranging gives:

$$P_o * (1 - \alpha) * \{1 - 1 / | \varepsilon_o | \}*(\partial Q_o / \partial L_o) = (1 + \alpha) P_G (\partial Q_G / \partial L_G) \text{ ---11.0}$$

Equation 11.0 then reduces to:

$$P_o * \{1 - 1 / | \varepsilon_o | \}*(\partial Q_o / \partial L_o) = \{ (1 + \alpha) / (1 - \alpha) \} P_G (\partial Q_G / \partial L_G) \text{ ---12.0}$$

which can be re-arranged as:

$$P_o / P_G = \{ (1 + \alpha) / (1 - \alpha) \} / \{1 - 1 / | \varepsilon_o | \} * \{ (\partial Q_G / \partial L_G) / *(\partial Q_o / \partial L_o) \} \quad -13.0$$

where $\{ (1 + \alpha) / (1 - \alpha) \} / \{1 - 1 / | \varepsilon_o | \}$ is the premium received for organic wheat over the GM wheat. It is evident from this equation that the smaller the elasticity of demand for organic products and the higher α for a given level of output, the higher will be the premium. The premium will also depend on the relative marginal productivities of GM and organic wheat production. The lower the marginal productivity of land in organic farming (or the higher the marginal cost), the higher will be organic wheat prices relative to GM wheat prices.

It is evident from the above equation that introducing a buffer zone explicitly to the model increases the required premium. This can also be reflected as an upward shift of the marginal cost curve for organic producers in Figure 1, resulting from having to compensate the producers in the buffer zone. The optimal organic output decreases to Q_1 and the price of organic wheat increases. If the buffer zone is specified at a fixed width surrounding the organic farm area, then the ratio of the buffer zone area to the organic farm area will decline as the organic farm area expands. In this case, the shift of the marginal cost curve would be a pivotal one (as opposed to a parallel shift). Implicitly, such a result suggests that it is cheaper to provide an effective buffer zone around one large contiguous land mass than many smaller individual operations.

Empirical Model and Results

Using the theoretical model developed in the previous section, a matrix of organic price premiums is calculated for various club sizes, demand elasticities, and buffer zone widths.

Comparing these premiums to actual organic wheat premiums allows us to determine the parameters under which an organic club can viably exist. The empirical calculation is divided into two stages. In the first stage, the parameter alpha (α) is calculated for several land-club sizes and buffer zone widths. We assume that the club shape is circular and has a circular buffer zone surrounding it. The total buffer zone area is a function of both the club size and an exogenously chosen buffer zone width. Because the buffer zone width necessary to prevent pollen drift is uncertain, we calculate buffer zone areas for widths varying from 100 to 400 meters. The club and buffer zone are illustrated in Figure 2. The specification of the club as circular allows us to calculate the parameter alpha as: $\alpha = (r_2^2 - r_1^2) / r_2^2$, where r_2 is the radius of the club area, r_1 is the radius of the buffer zone, and α is the relationship between the clubs radius and the width of the buffer zone. Calculated parameter levels of α for various buffer zone and club size are presented in Table 1.

In the second stage, α is used to calculate minimum premiums required for maintaining a landscape club that can maximize profits for its members and compensate farmers in the buffer zone. These premiums are calculated for club radiuses ranging from 1000 to 30000 meters, elasticities of demand ranging from 2 to 13, and buffer zone widths ranging from 100 to 400 meters. The results of the premium calculation are presented in Table 2.

It can be seen in Table 2 that as the elasticity of demand for organic wheat increases, the premium required to make the organic club viable decreases. Similarly, as the radius of the club increases the required premium decreases. In contrast, the width of the buffer zone appears to have little impact on the required premium. This is likely because the buffer zone width is very small relative to the club's radius. A review of existing yield and price data reveals that there is an existing premium of organic wheat prices over the conventional one, although the organic yields are lower than the conventional yields (see Table 3). Based on the figures in Table 3, it can be argued that an organic club that maximizes the welfare of the producers in the club while compensating the farmers in the buffer zone can be formed and maintained for some combinations of elasticities and buffer zone areas. These combinations are shown in Table 2 as bold characters.

Institutional Feasibility

Examining the economic feasibility is a first step in evaluating the practicability of creating an organic club on the Canadian agricultural landscape. A second step is determining the type of institutional arrangements under which an organic club could be created and maintained. In accordance with club theory, there are three relevant parameters pertaining to the institutional feasibility of the creation and management of an organic landscape club. First, do the farmers or landowners have the human capital and social networks to undertake such collective action? Second, is it constitutionally legal for a group of farmers or landowners to restrict the type of technology used within a fixed area? Finally, are there public policies in place that allow for monitoring and penalties in the event that non-permitted technologies are used?

There are at least two pieces of historical evidence where Canadian farmers have exhibited the social networking ability and level of coordination required to overcome collective action problems associated with different crop production technologies. The first evidence is the collective action taken by farmers and landowners when rapeseed was first introduced as a crop in Canada in the early 1960s. Rapeseed and mustard seed are genetically and visually indistinguishable, yet the oil and meal products derived from each crop are very different. For this reason, the two crops cannot be mixed. When rapeseed was introduced, there was no mechanism to mechanically separate it from mustard, so farmers and landowners collectively agreed not to grow the two oilseed crops in the same rural municipality (RM). If the majority of farmers in each RM wanted to grow rapeseed, then mustard was not grown. The opposite was true when farmers preferred to grow mustard. Each municipality made its own decision regarding which of the two crops to grow, and each municipality monitored and enforced this arrangement through moral suasion. There were no side payments made to those who did not participate.

A second historical example of successful social networking for the purpose of collective action is the notion of cooperatives. Farmers have a long history in the creation and operation of grain (and other) cooperatives in Saskatchewan for the purpose of earning higher returns or developing value-added (reference). While these cooperatives have not been involved in placing limitations on what can and cannot be grown in specific areas, they have created strong social networks of farmers, indicating that the level of cooperation required to create and maintain an organic club is possible.

Despite the evidence of producer cooperation described above, there is a noteworthy difference between the historical examples discussed here and the formation of an organic club that could make club formation difficult to achieve. In the first example, producers were merely deciding whether or not a specific crop variety should be grown, and regardless of an RM's decision to grow or not grow that crop variety, they were not required to change their farming practices. In contrast, the formation of an organic club involves producers within or outside the club committing to specific crop production technologies and utilizing somewhat different farming practices. A decision to form an organic club means that all producers within the clubs boundaries must produce organically, while those outside must use conventional or GM technology. Given the wide dispersion of organic farmers in Saskatchewan, this could only be achieved through having some producer's switching production technologies or moving their farm to a location where the technology that they prefer is permitted. The differing philosophical ideologies associated with each production technology suggest that either of these options could be problematic. On the other hand, when faced with the proposition of having one technology eliminated entirely, these options may eventually be deemed as a viable option.

The second parameter mentioned above has to do with whether or not farmers and land owners have the constitutional right to constrain what can be grown on specific landscapes. The *Canada Act* places the constitutional authority for the use of agricultural lands under the provincial government. However, some of the authority over the use of agricultural lands has been delegated to rural municipalities thought the *Saskatchewan Rural Municipality Act*. This act gives municipal governments the power to enforce specific agronomic practices. For example, rural municipal governments have the authority to remove named noxious weeds from farmer's fields and to make farmers pay the costs associated with monitoring and enforcing this policy. This suggests that by working through the various levels of government, producers do in fact have some control over the types of crops that can be grown on a given landscape.

The final parameter pertains to whether or not there are policies in place that allow for the enforcement of specific production technologies. Currently, there are no regulations preventing the production GM wheat on Saskatchewan farms. All varieties of wheat that are marketed through public marketing channels, such as elevators, must be registered by the government. Farmers can and do grow unregistered varieties on their farms but can only use the grain on-farm for such things as livestock feed. At present, the only reason GM wheat is not currently grown is because the company that did the plant breeding has not released the variety in any country. If that company chooses to release GM wheat in the United States for example, and the wheat is brought into Canada in a "brown bag", it could be legally grown. This suggests that current policies would make it difficult to enforce the use of specific production technologies if producers chose not to obey rules associated with maintaining an organic club.

Conclusion

This paper has shown that under existing organic and conventional prices and yields, it is economically feasible for organic producers to form an organic club with a buffer zone that allows both GM and organic production technologies to co-exit on a common physical landscape. In the case modelled here, co-existence results in an increase in economic welfare over the situation where only GM technology is used. The existence of a buffer zone around the organic club prevents contamination from occurring but at the same time causes economic injury to buffer zone farmers. However, the benefits accruing to organic club farmers are more than enough to compensate these farmers for their losses.

Despite these economic results, it should be noted that there exists a plethora of institutional and logistical problems associated with forming an organic club like the one described here. The most notable of these is the issue of organizing organic farmers into one contiguous land mass such that a single buffer zone can be created. Historical evidence suggests, however, that farmers are extremely adaptable and flexible in the face of adversity, and that although the formation of an organic club currently seems improbable, it should not be ruled out in the future.

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Table 1.0 Calculation of the buffer zone parameter (α)

Buffer zone (meters)	Radius of the club (meters)								
	1000	**2000**	**3000**	**4000**	**5000**	**7500**	**10000**	**20000**	**30000**
100	0.2100	0.1025	0.0678	0.0506	0.0404	0.0268	0.0201	0.0100	0.0067
200	0.4400	0.2100	0.1378	0.1025	0.0816	0.0540	0.0404	0.0201	0.0134
300	0.6900	0.3225	0.2100	0.1556	0.1236	0.0816	0.0609	0.0302	0.0201
400	0.9600	0.4400	0.2844	0.2100	0.1664	0.1095	0.0816	0.0404	0.0268

Table 2.0 Necessary Price mark-up

Radius of the club (meters)	Elasticities					
	2	3	4	5	10	13
	Buffer zone 100 meters					
1000	4.32	3.24	2.88	2.70	2.40	2.34
2000	3.46	2.60	2.31	2.16	**1.92**	**1.88**
3000	3.23	2.42	2.15	2.02	**1.79**	**1.75**
4000	3.12	2.34	2.08	**1.95**	**1.73**	**1.69**
5000	3.06	2.29	2.04	**1.91**	**1.70**	**1.66**
7500	2.98	2.23	**1.98**	**1.86**	**1.65**	**1.61**
10000	2.94	2.20	**1.96**	**1.83**	**1.63**	**1.59**
20000	2.88	2.16	**1.92**	**1.80**	**1.60**	**1.56**
30000	2.86	2.14	**1.91**	**1.79**	**1.59**	**1.55**
	Buffer zone 200 meters					
1000	7.25	5.44	4.83	4.53	4.03	3.93
2000	4.32	3.24	2.88	2.70	2.40	2.34
3000	3.72	2.79	2.48	2.33	2.07	2.02
4000	3.46	2.60	2.31	2.16	**1.92**	**1.88**
5000	3.32	2.49	2.21	2.08	**1.84**	**1.80**
7500	3.14	2.36	2.09	**1.96**	**1.75**	**1.70**
10000	3.06	2.29	2.04	**1.91**	**1.70**	**1.66**
20000	2.94	2.20	**1.96**	**1.83**	**1.63**	**1.59**
30000	2.90	2.17	**1.93**	**1.81**	**1.61**	**1.57**
	Buffer zone 300 meters					
1000	15.37	11.53	10.25	9.61	8.54	8.33
2000	5.50	4.13	3.67	3.44	3.06	2.98
3000	4.32	3.24	2.88	2.70	2.40	2.34
4000	3.86	2.89	2.57	2.41	2.14	2.09
5000	3.61	2.71	2.41	2.26	2.01	**1.96**
7500	3.32	2.49	2.21	2.08	**1.84**	**1.80**
10000	3.19	2.39	2.12	**1.99**	**1.77**	**1.73**
20000	3.00	2.25	2.00	**1.87**	**1.66**	**1.62**
30000	2.94	2.20	**1.96**	**1.83**	**1.63**	**1.59**
	Buffer zone 400 meters					
1000	138.16	103.62	92.11	86.35	76.76	74.84
2000	7.25	5.44	4.83	4.53	4.03	3.93
3000	5.06	3.80	3.37	3.16	2.81	2.74
4000	4.32	3.24	2.88	2.70	2.40	2.34
5000	3.95	2.96	2.63	2.47	2.19	2.14
7500	3.51	2.63	2.34	2.20	**1.95**	**1.90**
10000	3.32	2.49	2.21	2.08	**1.84**	**1.80**
20000	3.06	2.29	2.04	**1.91**	**1.70**	**1.66**
30000	2.98	2.23	**1.98**	**1.86**	**1.65**	**1.61**

Source: Authors' calculations

Table 3.0 Average wheat data in Saskatchewan: 2003

Technology type	Wheat Price $/tonne	Wheat acreage acres	Cost of production $/acre	Wheat yield tonnes/acre
Conventional wheat	159.00	11 000 000	133.20	0.80
Organic wheat	294.60 (*)	145 043 (**)	118.30	0.61 (***)
Genetically modified wheat	148.00		125.00	0.86

Sources: (*) Organic Crops Price Survey, SRC Publication, No: 10245-1F04, October 2004.
(**) Agriculture Canada Organic Statistics (2003)
(***) Personal Communication with Brenda Frick

Figure 1.

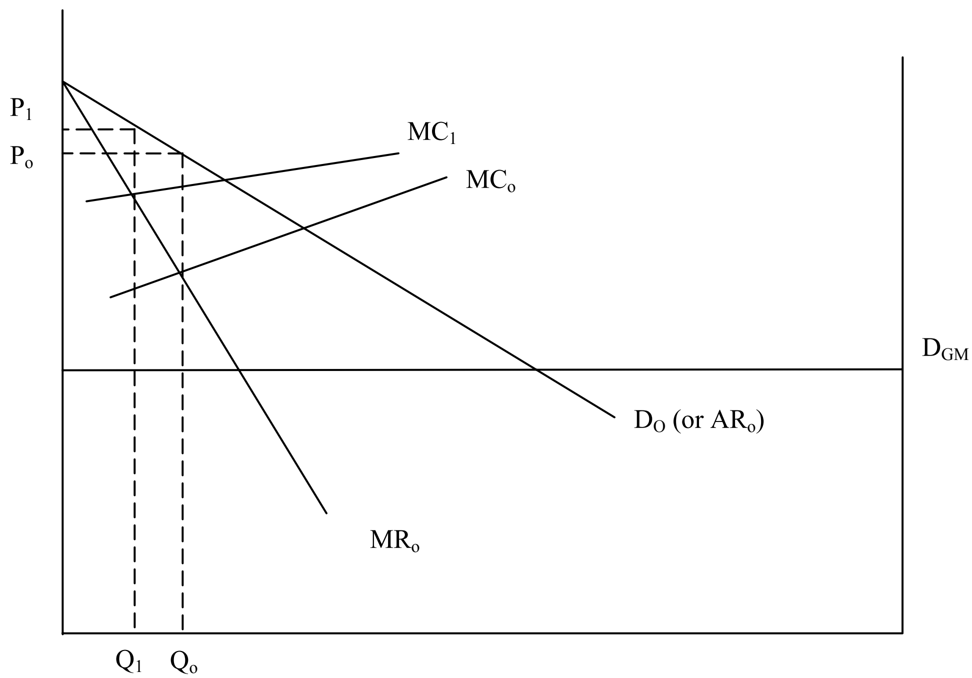

Figure 2. Specification of the landscape club and the buffer zone