Farmers' decisions regarding carbon sequestration:

A metaeconomic view

John Sautter, Natalia Ovchinnikova, Colby Kruse, and Gary Lynne

Working Paper (in Journal Review)

Sautter received his PhD in Political Science from the University of Nebraska-Lincoln (UNL) and now attends Vermont Law School where he is a research associate at the Vermont Institute for Energy and the Environment; Ovchinnikova, PhDs in Economics from both Moscow University and UNL, is an Assistant Professor in the Department of Economics at St. Lawrence University, Canton, NY. Colby Kruse, MS in Agricultural Economics from UNL,is an environmental consultant in Phoenix, AZ. Lynne is a professor in the Department of Agricultural Economics and School of Natural Resources, UNL; he is the corresponding author: glynne1@unl.edu

Abstract: The overall impetus for this research comes from the concern with global warming. Our purpose is to discover what motivates the adoption of technologies and practices that lead to sequestering more carbon in crop land to help reduce global warming. The data was collected from farmers in eastern Nebraska, USA. Using logit models, we found that farmers who condition their pursuit of self-interest with shared other-interest as represented in empathy and altruism are more likely to adopt conservation technologies. Self-sacrifice in both domains of interest is a main driver in conservation. Striving for more control in farming, however, reduces the probability of adopting conservation tillage. These findings give scientific reasons for a shift in the policy attention to encouraging the best balance in the mix of moral suasion to join the conservation cause and financial incentives, rather than trying to maximize the outcomes of either one.

Key words: self-interest, other-interest, metaeconomics, carbon sequestration, global warming

Recent trends in economics, sociology and psychology centered on a behavioral focus for hypothesis testing offer new avenues to explore the conservation technology adoption issue (Fehr and Fischbacher, 2003; Gintis, 2003; Ostrom, 2002). Innovative analytical tools developed in the behavioral sciences suggest a new path to overcome past obstacles. Conservation research has been moving toward an integrated multi-faceted approach that includes behavioral determinants for some time, but certain methodological obstacles have prevented a verifiable empirical test of such theories (Christensen and Norris, 1983; Lockeretz, 1990). Following what conservationist Lockeretz (1990) has stated, "the customary response to a gap in our knowledge is to call for more research… [b]ut if the gap persists, at some point the call should be not for more but, instead, for better." Thus, we have chosen an integrated approach using a behavioral economics basis in the spirit of finding a new and better way to narrow the gap in understanding conservation technology adoption in agriculture.

Nowak and Korsching (1998) have attributed inadequacies in U.S. soil and water policies to a misunderstanding of the human dimension of conservation practices. Citing a lack of consistency across conservation research on how to quantify the concept of conservation behavior, they echo Lockeretz's call for new and better research. Conservation technology adoption research has been hindered in the past by, inter-alia, a working definition for an integrative measure of farmer attitude toward adoption, incorporation of other's influence on an individual's adaptation decision, and a qualitative methodology capable of evaluating, as well as quantifying, normative trends in a geographic region (Lockeretz, 1990). Advances in experimental and economic psychology suggest that Nowak's and Korsching's (1998) human dimension may explain more about motivation in decision-making than an incentive based model of technology adoption premised upon self-interest (Andreoni and Miller, 1993; Fehr and Schmidt, 1999; Khaneman, Knetsch and Thaler, 1986).

New Theory Suggesting an Alternative Approach

Metaeconomic theory, first proposed in Lynne (1999), suggests one way to meet these shortfalls. This theory proposes to explicitly take into account both an egocentric-hedonistic based self-interest in profit and an empathetic-altruistic based other-interest in conservation. Metaeconomics contends that farmer conservation decisions involve the integration of a joint self-interest (as an incentive based traditional economic model suggests) and a community or shared other- interest represented in the social network (as the conventional sociological model suggests). This theory sees an element of truth in both approaches, and proposes that when adopting conservation tillage technology farmers have a non-separable, joint preference structure reflecting both interests…which are inherently in conflict… at the same time. Thus, we are testing in this study if the act of using conservation tillage directly contributes to satisfying two identifiable and unique tendencies in the human psyche: an economic need to maximize profits occurring at the same time with an innate desire to be in unity with group centered goals and norms about conservation (Lynne and Rola, 1988; Lynne, 1995).

This also suggests, as supported by the limited amount of research on the question, there is another dimension at work that includes self-sacrifice (Beedell and Rehman, 2000). When Willock et al. (1999) asked farmers to rank their agricultural objectives, farmers ranked intrinsic values, such as job satisfaction, as the most important. But when they were asked what characterized a successful farmer, farmers showed a tendency to relate to financial outcomes instead. These studies implicitly suggest, then, not only the conflict in these objectives but also that in order to achieve one objective, farmers are willing to, and indeed generally must, sacrifice something of the other, both at the same time.

This jointness, along with the conflict and the self-sacrifice it predicts, is illustrated in Figure 1. The figure appears a bit complex when first looking at it; please bear with us as we explain it. Farmers are complex, too, and we believe this is the easiest way to effectively represent their motivations and choices in conservation behavior. We start with the standard notion in traditional economics that farmers try to be cost efficient and try to maximize profits along path 0G, acting only on the egoistic-hedonistic based self-interest, and responding in the main only to financial incentives. These farmers see the need to move to point A due to no-till equipment and practices perceived as being expensive relative to traditional tillage equipment and practices (r_e large relative to r_d, as illustrated on R°R°). Similarly, starting with the traditional perspective in sociology that this is all about social networks, community and conservation norms, we would again expect the farmers to maximize, but now in the social domain, represented in moving along 0M, which defines the path through another set of iso-curves representing the individuals unity-with the conservation way of doing things in the community, doing what is best for the community at point C. Notice the huge sacrifice in material output (e.g. much less corn produced) as represented by $I_G°$ < I_G^3, which is recognized in the notion of "sacrificing for the greater good." What is not often recognized, which is now made clear by this model, there is also sacrifice in a farmer's own, internalized other-interest when maximizing profits, as shown by $I_M°$ at A < I_M^1 at C, i.e. in order to maximize profits the farmer is sacrificing connection with the greater cause of conservation, and being in unity with others in the community who believe in conservation, as well as sacrificing long term viability of the group and each farmer in the group. We now can suggest that conservation is about finding an appropriate balance in the joint interests. Thus, achieving a kind of peace of mind through some self-sacrifice in both domains as illustrated at points like B and B′ on 0Z.

To see this, consider the traditional policy approaches of either increased financial incentives on path 0G or moral suasion on path 0M. Consider, first, path 0G: this traditional economic policy approach suggests that if we could somehow make the perception of the price of conservation lower, farmers would expand conservation out to points like C or C′, a point where the dedicated conservationist kind of farmer is already located. So, we cost share, and pay farmers to be conservation farmers, with virtually always less than desired, often surprising, outcomes, now easily explained by this model. In the attempt to move all farmers at least to point C, and maybe even to C′, what happens is that even the most dedicated conservationist now starts to see conservation as something which is all about profits, so they move away from path 0M and head toward path 0G; at the same time, the profit maximizers are reinforced in the view this is all about profits, and, with former conservationists now induced to also act more like profit maximizers, the net result could be less overall conservation at points like A′ with now all the farmers located here. So, policy and programs based on the self-interest contention could easily go awry.

Now consider policy touting path 0M: We can see why farmers resist moving to point C from A, with perceived corn output (and profits) substantially lower, with $I_G°$ at C < I_G^3 at A. We might be able to move them to point B, where the sacrifice is much less, if we recognize there is indeed self-sacrifice at work, and acknowledge them for it. We can also see that to move them to C′ will take both more cost sharing to increase R° to R′ as well as technical support to lower the perceived $r_e°$ to $r_e′$, in addition to moral suasion. Yet, most importantly, we need to understand that a policy based on moral suasion is about encouraging more self-sacrifice in the material domain, which also explains why the income, financial capacity of the farmer is so important. One needs to able to afford the self-sacrifice, which also explains why larger farms with more financial capacity are better able to move to points like B, because this is all about sacrifice in income, not about maximization of income.

All this suggests the real policy challenge is to find that just right mix of appealing to the farmer's self-interest in profits and the other-interest in being in unity with the cause, recognizing there must be a realistic expression of self-sacrifice in both domains at the new point B.′ While the strong conservationist farmer may have not gone quite as far as those implementing the program thought they would due to the policy or program making conservation a material item in the mind of the conservation farmer, those focusing only on the material have also moved. So, we move all the farmers, on average, out to point B′ which is superior to either point A′ or C′. In fact, there can even be a kind of synergy that occurs at such points B′ wherein the sum is greater than the sum of the parts, i.e. both those receiving and paying for the now greater conservation services I_M^2 but still reasonable level of perceived material (e.g. corn) output I_G^2 are better off than when extreme, maximizing positions are taken in either of the other domains. This is illustrated by the interest frontiers in Figure 2 becoming ever further apart for equal increments in capital R, perhaps equal increments in more cost sharing, as we move along path 0Z. A bit of sacrifice in both domains goes a long ways to making both the individual and the group better off. Yet, notice again that at points like B in Figure 2 there is some self-sacrifice in both domains (e.g. compare B to A and to C), a necessary condition in order to achieve more overall output from both domains. The technical details relating to this notion of synergy, and other refinements in this theory, are elaborated elsewhere (for more on these and other technical details, see Lynne, 2006a,b).

Also, this is not only about self-sacrifice, but it is also about control and self-control. Moving along path 0G is to express ever more control over the production process, e.g. with heavy tillage to control weeds, and to make the ground ready for planting earlier in the spring. Moving along path 0M is to give some control to nature, being more integrated with it, helping the carbon cycle restore the soil and stopping global warming. Path 0M is also all about giving over some control to others, as the attention on 0M is toward everyone, together, seeking more sustainable paths for the group of farmers in a community over longer periods of time. And, perhaps most importantly, it will take more individual self-control to stay the path 0Z than either of the more clearly defined paths 0G (by the market) and 0M (by the community). Farmers will be tempted by the money to go back to path 0G, or perhaps tempted to give into the social norms on 0M, rather than acting independently and courageously, albeit with empathy and some degree of altruism on path 0Z. Overall, the preference for control and the ability to take control, then, also become other major factors in explaining conservation behavior.

Farmer adoption of conservation tillage provides a unique opportunity to study this jointness, sacrifice and control phenomena. Conservation tillage is an environmentally conscious type of crop production technology that traps carbon in the soil, virtually turning the land into a carbon sink (U.S. Department of Energy, 1999). It has the potential to provide a public benefit by slowing the pace of global warming. However, conservation tillage takes more farmer skill and effort than conventional crop production, and equipment is more expensive.

Furthermore, it can raise the risks and costs of farming, e.g. in being delayed in planting the spring crop due to the soil not warming as quickly, or perhaps from holding too much moisture, both examples of losing control. In effect, while benefits are higher, costs may be substantively higher as well. In some cases, financial costs could even be greater than the benefits. This apparent contradiction and conflict supplies an occasion to search for alternative reasons for conservation technology adoption along with increasing production and profit.

In short, it is our contention that there must be a non-profit maximizing motivational factor I_M affecting farmer decision-making that goes beyond a mere interest in profits represented in pursuing more I_G. Our hypothesis is that those farmers who integrate their egoistic-hedonistic and empathetic-altruistic tendencies will adopt conservation technology at a more reasonable rate, higher than that observed for the extreme profit maximizers and somewhat less than observed for the extreme conservationists. In effect, empathy and altruism, as well as control, all work to temper the pursuit of self-interest toward a more reasonable path 0Z.

Toward Empirical Testing

In order to test this hypothesis of joint interest, inherent self-sacrifice and that those wanting more control will also not act as often like the conservation farmer, we developed proxy measures for these interests and control phenomena, bringing them all together in a probability model taking this form:

$$\Pr(0,1) = f[\mathit{Selfishness} * \mathit{Empathy}(\mathit{or\ Altruism}), \mathit{Selfishness} * \mathit{Control}, \mathit{Habit}, \mathit{Financial\ Capacity}]$$

where CT = 0 is a farm entirely under intensive tillage while CT = 1 means the farm has at least some conservation tillage. We now explore each of the independent variables.

Interaction of Self-interest With Empathy. Farmers' perceptions of attributes of an agricultural technology help determine their adoption choices (Adesina and Zinnah, 1993). Skaggs (2001) found that grower optimism regarding the future of chile production in New Mexico was related to an increasing probability of high-technology irrigation. The intriguing question is: Do farmers condition the way they act on these self-interest attributes as influenced by social norms and outside influences of others in community who express these norms? We characterize this as the phenomenon of empathy, defined herein as "walking-in-the-shoes" of these others (characterized as the moral sentiments in Smith, 1790; for the various definitions of empathy, see Wispe, 1987), which could move a farmer from strict adherence to path 0G toward some path 0Z. This is to say, and empathic farmer might ask: "Is this really how we ought to treat the soil and the atmosphere? How would I want to treated?", and then by tempering one's self-interest, acting somewhat differently. Lynne et al. (1995) found that individuals who are more willing to be influenced by the community, i.e. walking-in-their-shoes and conditioning their own self-interest accordingly, will be more likely to adopt micro-irrigation and to adopt this technology more intensely (Lynne et al., 1995). In fact, integration into support networks is associated with higher rates of adoption of conservation practices in general (Nowak and Korsching, 1983).

Interaction of Self-interest and Altruism. In addition, there might be actual self-sacrifice, as again reflected in moving toward some path 0Z and away from path 0G. That is, the act of conservation at points on path 0Z is also an expression of altruism, arising out of the empathic act involving the imagined projection into the state of others. It is important to acknowledge, however, that not everyone will be altruistic after said projection; some will stay the path 0G, while others will temper their self-interest, acting with altruism on path 0Z. The act of altruism is more about the matter of the degree to which there is self-sacrifice, and, as noted earlier, sacrifice in both realms of interest.

Interaction of Self-interest and Control. Using the same basic model proposed herein to guide the empirical testing, Lynne et al. (1995) suggested that the notion of perceived behavioral control (also drawing on Ajzen, 1991) influenced whether or not an individual adopted water-saving technology. Even more intriguing, this model suggests that having the need for less perceived control, e.g. not being as concerned over losing some control over the planting date in the spring in a no till field, could temper the self-interest, leading to more conservation tillage.

Habit. Metaeconomics suggests that most farming decisions run largely on emotion, more or less sub-conscious feelings about what has worked in the past, and idea supported by empirical research in economic psychology (see Kahneman, 2003). So, if someone is on a path 0Z, it is more likely the path will be maintained through time. In effect, we propose that consciously cognitive, rational calculation and consideration of using more conservation tillage happening at some earlier time simply leads to underlying, less than cognitive, feelings reflected in habits guiding what is done today.

Financial Capacity. Lynne and Rola (1988), Lynne (1995) suggest that the actual amount of control a farmer has in a situation as reflected in the financial capacity of the farm also needs to be considered, thus going beyond Ajzen (1991). Finding that actual farm income is a significant variable in predicting agricultural practice behavior supports standard derived demand (economic) theory. However, inclusion of perceived control in the model generally improves the prediction of actual behavior over a standard economic model, so both measures of control need to be represented. Lynne et al. (1995) claim the significance of perceived control in addition to financial control indicates farmers in Florida did not perceive they had complete volition in deciding whether or not to invest in micro-irrigation technology as presumed in standard economic modeling. That study further indicates a backlash by farmers against excessive control when it comes to the adoption of micro-irrigation technology. To avoid this problem, “Farmers need to perceive at least some control in order for them to move forward with technology decisions; with more (internal) control, farmers are more likely to take action, and to invest more intensely”. The significance of these findings rests in the suggestion that coercive control could be counterproductive.

Farm size is often found positively related with the overall adoption of conservation practices (Feder and Umali, 1993). Farmers appear to believe that their farms are too small to justify the large per-acre expense of adopting a new conservation technology. So, as farm size increases, the probability of utilizing newer conservation technologies also increases (Norris and Batie, 1987). Importantly, farmer financial capacity tends to be highly correlated with farm size, and is perhaps a better variable to consider; it has regularly been found to be a significant predictor of agricultural behavior (Kaiser, Wolfing and Fuhrer, 1999). Yet, some also have claimed that the use of conservation tillage is not constrained by low income or high debt, which is quite possible if an “other-interest” motive is strongly at work. We would expect, however, that a certain threshold level of financial capacity is necessary not only for survival but for installing conservation practices (Norris and Batie, 1987), especially given that self-sacrifice is likely a major feature of conservation.

Survey Methodology and Measurement

A total of 4200 surveys (17 pages each) were mailed to the farm operators in 8-counties in eastern Nebraska, with 1185 surveys returned (28.2% response rate). Due to some surveys missing more than 2/3 of the responses, this was reduced to 770 surveys used for statistical analysis. For these 770 responses, mean substitution was applied to missing data.

Measuring the Dependent Variable

Conservation tillage is defined as a situation where a residue cover of 30% or greater is left on the soil. So, a value of “1” simply means that at least some of the cropland on the farm has this condition, while a value of “0” means that all the cropland has something less than 30% in residue cover. This variable was derived from Question #6 (Q6) in the survey instrument (for all the questions providing data for the analysis, see http://www.carbon.unl.edu/hallcountysurvey05.pdf , or contact the authors).

Measuring the Independent Variables. Questions used to elicit data on the interests of farmers are similar to the belief and value components normally found in expectancy-valence models (Feather, 1982) as demonstrated in many different social science approaches, e.g. in the widely applied theory of planned behavior, a huge literature providing further testing of the proposal in Ajzen (1991). We borrow ideas from that literature in constructing the questions.

Our first task was to ask respondents to identify particular belief characteristics about individual centered aspects of conservation technology, like costs, effectiveness, and efficiency. Farmers were asked to rate their beliefs on a 7-point probability scale ranging from highly unlikely (probability of near zero) to highly likely (probability of near one). For example, the following statement was given to respondents (this item being one of several in Q12)

"Using a conservation tillage system results in increasing financial risks":

Highly unlikely					Highly likely	
1	2	3	4	5	6	7

We then asked each respondent (see Q13) to rate the value they placed on the outcome of this belief, another 7-point scale from Low Value = 1 to High Value = 7. These are then multiplied, to create an index for each beliefXvalue condition. We used the weighted average for several of these kinds of items as the measure of the self-interest tendency.

The proxy index for the altruism form of the other-interest was developed in much the same manner, but with the focus on causes or ideals with which the respondent may seek a feeling of unity. An average of the responses to the following items from Q12XQ13 were used to form the altruism variable: Greater environmental stewardship; increasing my ability to provide for my family; creating a healthier environment for my family and the community; helping to combat global warming; building organic matter in the soil; sustainability of agriculture over the next 50 years; reduced levels of carbon dioxide in the atmosphere; and protecting soil from erosion while still allowing it to be farmed intensively.

Empathy was proxied by focusing on the extent of outside influence, in the form of both “outside-governance” and “control”. Coercive types of outside influences could be brought forward by such entities as a regulatory agency (governmental or otherwise) or a landlord as in requiring certain conditions in a contract. Farmers might be voluntarily influenced by close friends and neighbors, or county extension. Belief X value indices for this empathy variable were derived from the average response to all the items in Q16XQ17.

The control variable as it relates to such things as concern over soil moisture, soil temperature or the appearance of conservation tilled fields was measured using the average response to the items in Q14a. This question had the form “My use of conservation tillage practices is limited by…”, regarding issues like “concern over soil temperature at planting time.” These statements are given a numerical value based on a 7-point unlikely to likely scale.

Habit was measured by Q8a, which asked about the percentage of the farm under conservation tillage over the last 5-years. If the tendency was toward more of the farm being under such tillage, the value becomes larger.

Financial capability was measured using Q29. A larger value means more financial capacity to adopt conservation tillage.

Results and Discussion

The statistical results provide support for the hypotheses suggested by the metaeconomic model. Farmers who are more empathetic and/or altruistic temper their self-interest and move on paths like 0Z rather than 0G, as suggested by the positive, statistically significant parameters on the self-interest times empathy and self-interest times altruism variables in Table 1. More specifically, farmers who walk in the shoes of others who think the farmer really should practice conservation tillage (as measured in the empathy variable from Q16XQ17) and/or are willing to sacrifice some material gains for the greater good (stewardship and other items in Q12XQ13) are more likely to be on path 0Z.

Also as expected, those who see conservation tillage as taking away from their control and, thus, from their ability to pursue only self-interest, are less likely to be on path 0Z, as indicated by the negative sign on self-interest times control (Table 1). This negative effect is even more pronounced in the altruism model, probably due to the empathy variable also carrying some coercion by others. So, when we remove this part, the parameter on the control variable increases.

Habit plays a positive role. As the model proposed, those already on path 0Z will be likely to stay on that path, in that the cognitive load to act on feelings arising on how things have worked in the past is a less costly basis for choice. Intriguingly, though, habit plays a stronger role in the altruism model, which is a stronger, more robust model overall. It seems that farmers doing conservation tillage are indeed converting their empathy into altruistic actions, and it has become a habit to do.

Financial capacity, also as expected, plays a positive role. One cannot adopt technology without the capacity to pay for it. Perhaps even more importantly, a conservation farmer must have the capacity to take some loss, to bear the costs of self-sacrifice, the latter being inherent in conservation technologies.

Summary and Conclusion

In this paper we have proposed an alternative theory for understanding conservation decisions. Following advances in bio-psychological and neural sciences, this alternative map of decision-making recalibrates the old models, bringing them in tune with modern discoveries. Whether it be the Freudian-psychoanalytic framework, or the Christian notion of the holy trinity (with the third part resolving the internal conflict between self and other), cultural manifestations and more recently, empirical measurements, all pointing to the dual motive theory, are present throughout history and science.

The metaeconomic model shows how this new theory is highly important to the economic and social science community, including the policy process. The high statistical significance of the interaction terms used in the econometric model suggests that there is a dual motive structure to human decision making. Now that empirical testing can show that there is more affecting farmer decision-making than only raw self-interest, or single-minded attention to the common good, private and public policy can be updated, now on scientific basis, to allow for other modes of implementation. It is time that consumers and policy makers alike, whether farmer or economist, begin to take back ground lost to both the narrower versions of human behavior exemplified in traditional economics and conventional sociology, and thus open the door to building policy and programs reflecting actual human nature as illustrated in this new integration.

Acknowledgements

Table 1. Metaeconomic results explaining the probability of adopting conservation tillage by the integration of self-interest and other-interest (empathy, altruism), as well as perceived and actual control, in eastern Nebraska, U.S.A., 2006.

Independent Variables	Model 1	Model 2
Constant	.171	-.204
Self-interest X empathy	.010[a]	
Self-interest X altruism		.051[a]
Self-interest X control	-.076[a]	-.115[a]
H (habit)	.194[c]	.311[a]
R (financial capacity)	.003[a]	.003[a]
% correctly predicted		
CT=1	94.8	95.9
CT=0	33.3	22.6
overall	80.3	73.6
-2 Log likelihood	378.440	362.657
Nagelkerke R^2	.241	.270
Chi-sq. (Hosmer and Lemeshow test)	6.143	5.252

a – $p < 0.01$; b – $p < 0.05$; c – $p < 0.1$

Figure 1. Joint self-interest (G) and other-interest (M) isocurves for a conservation input (e) and all other inputs (d)

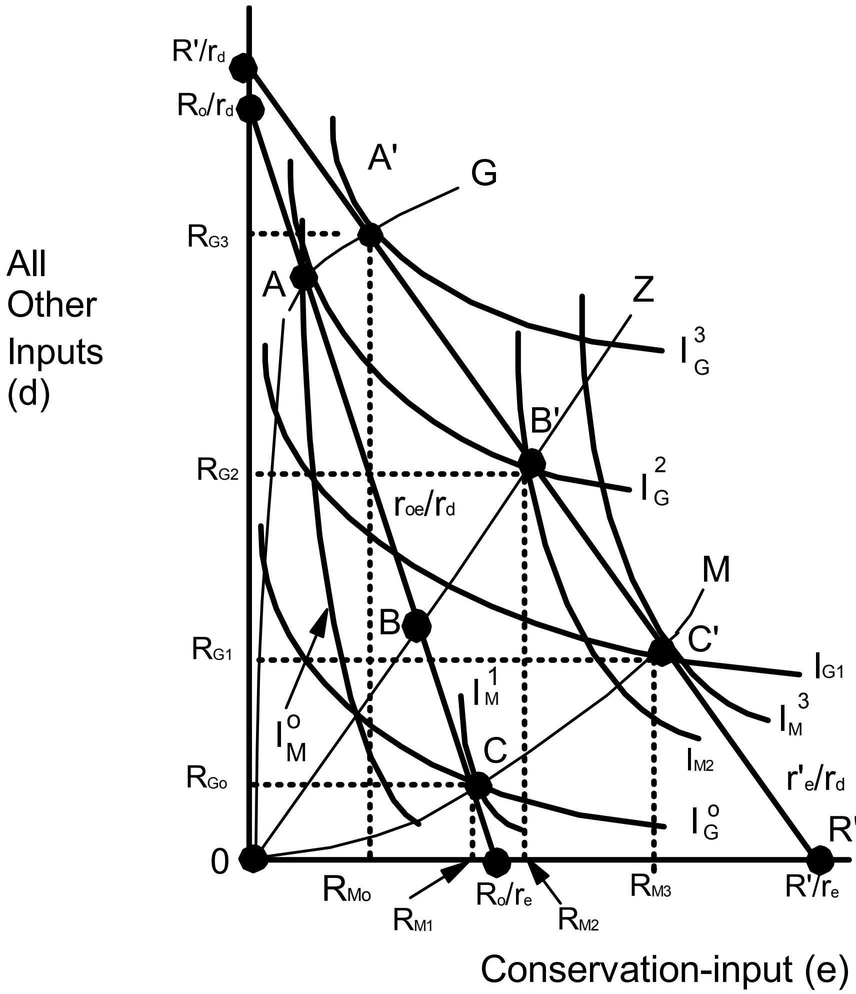

Figure 2. Ego-empathy frontier representing synergistic balancing in the joint pursuit of the egoistic-hedonistic self-interest (I_G) and the empathetic-altruistic other-interest (I_M) while sequestering more carbon in agricultural land.