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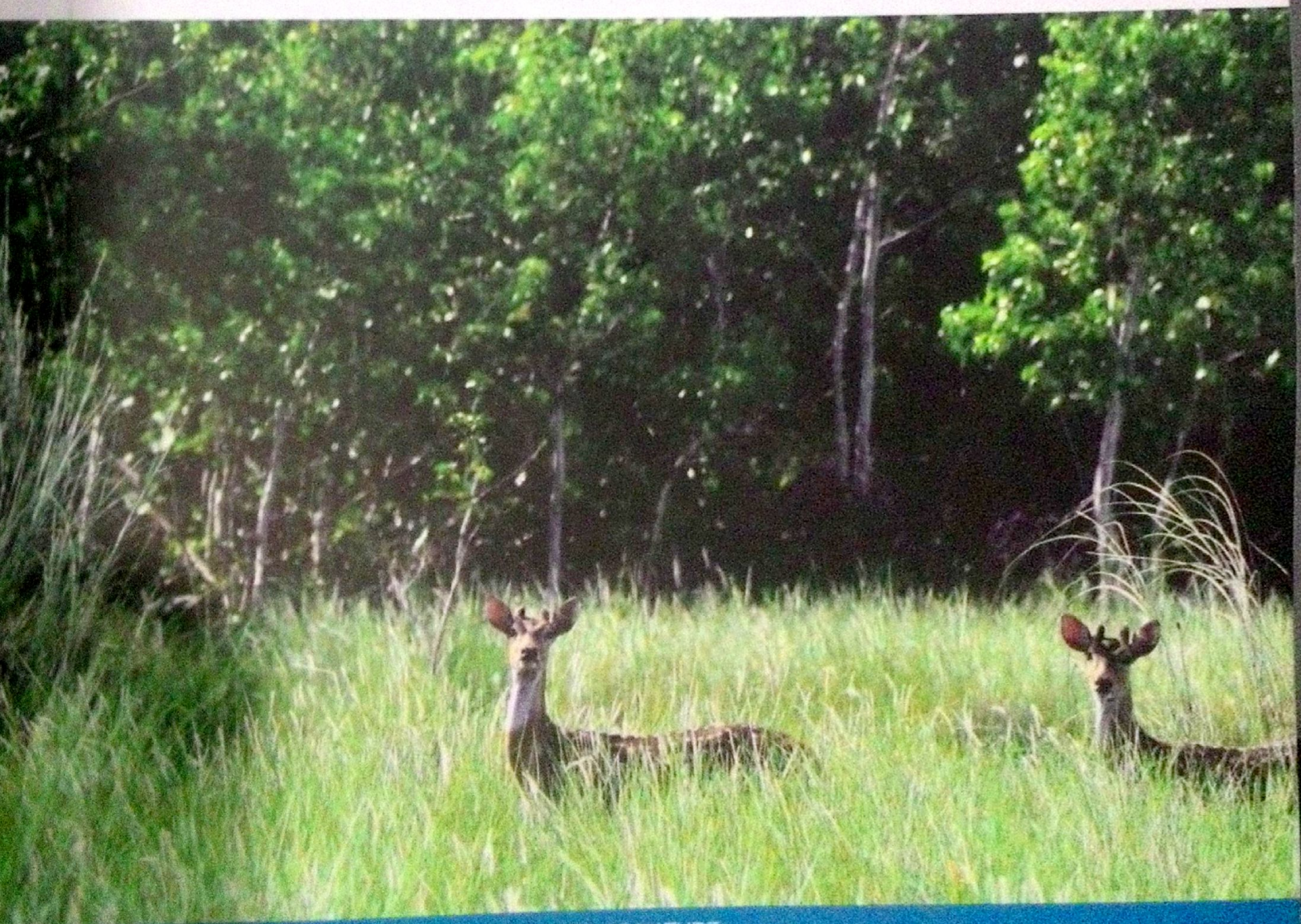
Bangladesh Sundarban Delta Vision 2050

A first step in its formulation

Document 2: A Compilation of Background Information



INTERNATIONAL UNION FOR CONSERVATION OF NATURE

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A Compilation of Background Information

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Bangladesh Country Office
November, 2014

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Economic Valuation of Ecosystem Services

Professor A. K. Enamul Haque and Dipankar Aich

6.1 Introduction

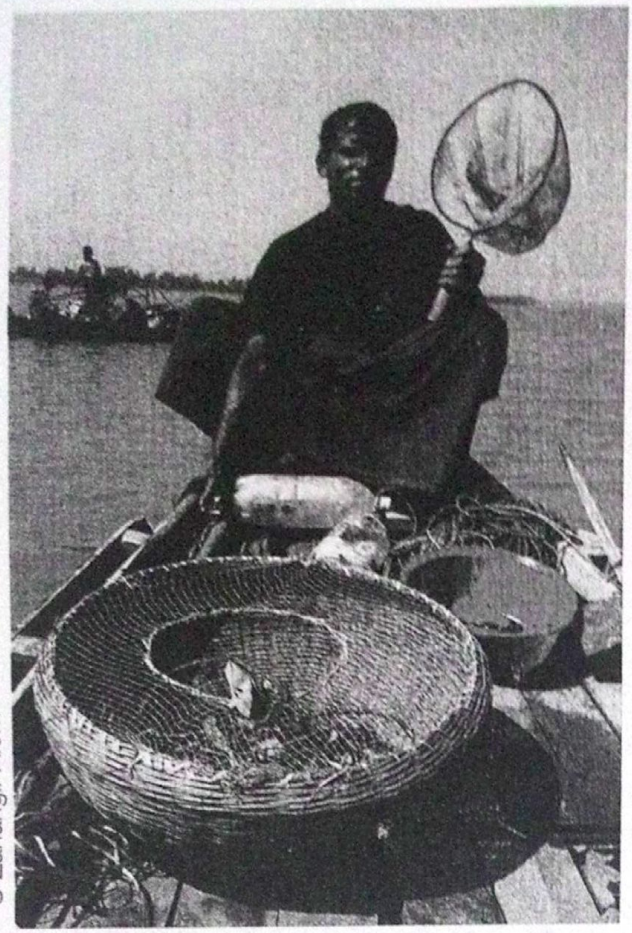
The Sundarban Reserved Forest (SRF) is a world heritage site (UNESCO, 1987) and the largest mangrove forest that remains on the planet shared between Bangladesh and India. The value, arguably, of such a forest is "priceless". However, plenty of projects have been implemented in both the nations to safeguard it from degeneration and depletion. International Union of Conservation of Nature in Bangladesh (IUCN, B) has designed long-term policy driven programmes with the vision of conserving the SRF based on many years of field and policy related experience in Bangladesh and around the world. A total of twenty-two programmes under four major policy options (Appendix 6), that has a direct impact on the conservation of the forest, were designed by IUCN.

The main objective of this study is to understand the impact of these programmes not only in terms of its immediate benefits and costs, but also the long term derived benefits from conserving the ecosystem (both directly usable and non-usable yet indirectly beneficial).

6.2 Concept of Economic Value of Resources and Methods of Valuation

Economic value of a resource refers to both use and non-use value. The concept is enshrined in the foundation of Welfare Economics. It refers to the increase in the well-being of people due to use of a resource (today or in future periods) and/or due to existence of a resource. Thus, Total Economic Value (TEV) of any resources is divided in two parts: use value and non-use value of resources.

Finding theses values are really tricky due to the fact that most of the environmental or ecological services are non-marketed and hence does not have a market price. Moreover, when a market price for a resource exists, the complexity of market structure (or due to



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Crab harvesting

government regulations prices) often do not reflect the true 'opportunity cost' of resources. Many of the natural resources suffers from the fact that its management are weak and so they are over-exploited, its prices are regulated and so its prices are smaller than its true market price and so natural resources often suffers from over exploitation, which is referred as 'the tragedy of the commons' in the literature.

However, besides the productive and direct services of the ecosystems, there are many indirect services of an ecosystem that cannot be fully valued. As a result, resource management was often guided by extraction of productive and marketed services of the ecosystem. This led to deterioration of its quality and in many cases even led to depletion. Against this background environmental and resource economics provided the conceptual framework for valuing the resources. This is discussed in many studies and books Freeman (1999), Haque, Murty, & Shyamsundar (2011), Rietbergen-McCracken & Abaza (2000) and in many other books and journal articles.

The objective of finding values of ecological services is to determine objectively, without prejudice, the ultimate price that human beings will have to sacrifice without these services. There are many methods to find these values. Of them, the methods that can assess the values more appropriately include production method, contingency valuation method, hedonic pricing method and ravel cost method. However, due to non-availability of data (mostly time series) or lack of authentic information, economists also used replacement cost method, opportunity cost method, avoided cost method, damage cost method and many others methods. For the purpose of project design or for understanding economic values in a very short period of time, benefit transfer methods have been used by many economists.

6.3 Ecological Services of a Resource

There are several types of ecological services that a mangrove ecosystem provides to us which increases our net well-being. These services are broadly categorised in four parts: a) provisional services, b) regulating services; c) cultural and religious services and d) supporting services. Provisional services include direct and indirect services that the ecosystem provides. Millennium Ecosystem Assessment (MEA, 2003) has defined a number of these services either marketed or non-marketed, or partially marketed goods or services as "Ecosystem Services" (ES) and defined them conceptually under four pillars: support, regulatory, provisional and cultural services. Studies on valuation ecosystem services often categorized the values under these major headings. In this report an attempt has been made to estimate the value of the ecosystem services of the Sundarban forests.

6.4 Valuation of Ecological Services of the Sundarban

Total values of ecosystem services of any resources are difficult to find because each aspect of the valuation requires a different approaches and different data set. It requires meta-analysis where many studies on various aspects of ecosystem services are analysed and values are estimated from which economists often estimate a possible range of values. On the top of those, there is a large degree of uncertainties on the services and many of the services are correlated both positively and negatively. As such, a straight summation of the various values is also subjected to double counting in some cases. Given this, and given the very short period of this assignment, we used a) Delphi technique to elicit important services of the Sundarban ecosystem; b) collated results of meta-analysis from around the world to build a more reliable range of the values given the degree of uncertainties related to Delphi techniques with limited time-resources and the degree of uncertainties. Therefore, the results of meta-analysis are also used to validate or to triangulate the findings from Delphi techniques.

6.5 Delphi Approach: Eliciting Proxy Values Using a Project Profile

The Delphi method is used by economists to derive values which cannot be readily estimated. It often uses face-to-face in-depth interviews with experts (who have sufficient knowledge of the ecosystem services) and derive consensus on the values. Since the Sundarban is quite large and services are difficult to quantify, we used a typical conservation project developed to protect and improve the ecological services in certain specific parts of the Sundarban. As such, the reported values are likely to be within a reliable range of estimates and the convergence of opinion among different foresters was very quick. For each program of intervention, the duration of the program, the amount of costs involved and the zone of influence were pre-determined.

Step 1: Listing of ecosystem services using the Sundarban Conservation Project of IUCN

Table 6.1 provides the list of services initially identified by the participants in the Delphi Technique. It shows that about 29 different services that were identified by the foresters who are familiar with the Sundarban, its activities and are also aware of the ecology of the Sundarban.

Fishermen returning with the catch of the day

Table 6.1: List of Ecosystem Services from the Sundarban

Sl. No.	Ecosystem Services of the Sundarban
1	Aquatic Habitat maintenance
2	Biodiversity enhancement
3	Biological regulation
4	Climate regulation and disturbance regulation
5	Climate resilience
6	Climate resilient program development
7	Climatic regulation and Biological regulation
8	Eco tourism enhanced
9	Fish migration routes and seed dispersal improved
10	Food and Genetic Resources
11	Food- restoration of fish migration routes
12	Genetic resources and Raw materials
13	Genetic Resources
14	Habitat improvement
15	Resource stock enhanced
16	Habitat maintenance and enhancement
17	Habitat quality improvement - maintain tidal nature of mangrove
18	Habitat restoration
19	Habitat restoration and increase of net primary production
20	Loss of human and tiger
21	Navigation & fish population enhanced
22	Nutrient regulation
23	Protection of fish habitat
24	Protection of fish habitat and increase of net primary production
25	Raw materials
26	Recreation and Science and education
27	Safer cattle population
28	Science and education
29	Tide water flow improved. Fish passes improved

Source: List of ecosystem services from the Sundarban Conservation Project.

It is evident from the table that experts had project activities in their mind and so while they are concentrating on the values of ecosystem services, they were mostly engrossed with project activities. Nevertheless, familiarity with the project activities provided insights and they were able to generate some values. At the same time, since the projects did not consider all parts of Sundarban, their estimates will be taken as the lower bound of estimated values of ecosystem services. The upper ranges will be determined using the results of the meta-analysis.

Step 2: Reclassification of Ecosystem Services and Economic Values per ha per year

The first stage of the Delphi method provided Table 6.1, which lists the different types of services to be derived from specific programs of conservation under the Sundarban Conservation Project. Experts were then asked to discuss the options and services together in order to derive values under each options of intervention. It was revealed and agreed later that option 1 is unlikely to increase specific services of the ecosystem but it is important to ensure the overall integrity of the project. As such, experts provided a 'gross value' for the services derived from each of the strategic intervention options except for option 1. It was also concluded by the experts that option 5 does not separately generate new benefits but it is also a critical component to ensure that options 2 through 4 remains capable to increase the overall well-being of human being.

Table 6.2 shows the frequencies of responses under different options for different programs to conserve biodiversity of the Sundarban (in total 22 different programmatic interventions were discussed as shown in Appendix 6). A number 7 in column 1 for Provisioning services (Food) means, of the different interventions 7 were expected to generate this service. Similarly, a number 19 in column 1 for 'cognitive development' means, 19 of the 22 interventions are expected to derive this service. This is the result of the consensus reached by the experts involved in the Delphi approach.

The last (bottom) row in Table 6.2 provides the value of benefits derived from such services. Accordingly, the experts concluded that policy Option 2 is likely to generate a total value of $137.19 million if it is implemented. The value under Option 3 is $ 140.71 million and for Option 4 it is $ 24.26 million. In total each ha of the Sundarban, if conserved appropriately, will generate nearly $ 302.16 million for a period of nearly 22 years. These benefits are valued for the project area only. At the same, it only includes the values for which a consensus was reached among the experts. At the same time, there are few values for which a consensus was difficult to reach.

Separating shrimp fries

Table 6.2: Economic Values of the Sundarban per ha per year

Sl No.	Ecosystem Services	Total (1)	Option 2 (2)	Option 3 (3)	Option 4 (4)
		Frequency of Responses			
Provisioning services					
1	Food	7	4	3	
2	Water	3	2	1	
3	Raw materials	3	2	1	1
4	Genetic resources	8	5	3	1
5	Medicinal resources				
6	Ornamental resources				
Regulating services					
7	Air quality regulation				
8	Climate regulation	8	5	3	1
9	Moderation of disturbance	7	4	3	
10	Water flow regulation	6	4	2	
11	Waste treatment				
12	Erosion prevention	2	2		
13	Soil fertility maintenance	2	1	1	
14	Pollination	4	1	3	
15	Biological control	12	7	5	1
Habitat services					
16	Nursery service	9	4	5	1
17	Gene-pool Protection	12	6	6	1
Cultural services					
18	Aesthetics information	4	3	1	
19	Recreation	3	3		
20	Inspiration for culture and art	5	3	2	
21	Spiritual experience				
22	Cognitive development	19	6	13	1
Total value for project area in million $		302.16	137.19	140.71	24.26

Note: Analysis of the Delphi Responses; There are 22 different programs in the Sundarban Conservation Project and the value in a cell indicates the number of times a services is generated.

Accordingly, in terms of per ha benefits the value of the ecosystem services is $105.07 per ha per year while the upper limit is around $ 840.59 per ha per year. This upper value includes

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a few other important services of a mangrove like waste treatment, water regulation, and a few others, which is nearly 7 times of the values of other services of a mangrove ecosystem (Costanza *et al.*, 1997) and were not listed as the relevant services from the Sundarban Conservation Project activities.

The study used in this case were derived value for ecosystem services of the Sundarban forests did not consider all aspects of ecosystem services of a typical mangrove system. For example, values of the storm protection services of the Sundarban were not discussed (since the project was only for a part of the Sundarban). Therefore, this total value (per ha) in this case can only be a part of the values of ecosystem services of the Sundarban. Therefore, other published values of mangrove ecosystems are used to supplement this estimate.

6.6 Meta-analysis Results

Meta-analysis uses published results and then econometrically estimates parameters to derive values of ecosystem services. The primary reason for such an approach is to reduce uncertainty of values. Our search on published values resulted in three major meta-studies which can be used to validate /or supplement our Delphi results.

Costanza *et al.*, (1997)

Costanza *et al.*, 1997 in their paper published in Nature asserted that "the services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet."Costanza *et al.*, 1997, therefore, completed a meta-analysis of 17 ecosystem services of 16 biomes in the world. For a mangrove ecosystem, the estimate value is between 9,990 and US$ 19,580 per ha per year. They also found that total annual flow of ecosystem services is nearly 2 times the value of global GNP for the entire world.

Groot *et al.*, (2012)

Groot *et. al* (2012) provided an overview of the values of ecosystem services of 10 main biomes. They used 320 publications covering 300 case studies from different locations of the world. In total, they had 1350 different value estimates and a selection of 665 values was used in their meta-analysis. Their study shows ecosystem service value is $ 491 per ha per year. They scanned through many studies using different valuation techniques. According to Groot *et al.*, (2012) "there is a considerable level of uncertainties and contextual nature of any valuation" and while the global average is $ 491 per ha per year it is nearly $ 350,000 per ha per year for ecosystem services of coral reefs. This study shows that for a coastal wetlands ecosystem the value of ecosystem services is around 193,845 $ per ha per annum. This study used 139 different estimates that has a median value of $12,263 per ha per annum, and a minimum value of $ 300 per ha per year to a maximum value of $ 887,828 per ha per annum (Costanza *et al.*, 1997, Table 6.3).

Brander *et al.*, (2012)

Brander *et al.*, (2012) did a meta-analysis on the value of ecosystem services in Southeast Asia. Their study examines the value of ecosystem services provided by mangroves in South East Asia. In 2007 prices, they used 130 different estimates to derive the value of ecosystem

services. The mean value for ecological values, the study shows a mean value of $ 4,185 per ha per year and a median value of $239 per ha per year (Costanza Table. 6.3).

In addition, this study also shows (using 130 different studies) that each ha of additional mangrove would provide a value of 229.45$ per ha per year as value for coastal protection.

Uddin *et al.* (July 2013)

The most recent valuation study by Shah Uddin *et al.* (July 2013) estimated the value of the provisioning and cultural services of the Sundarban forest. The study identified timber, fuel wood, fish, thatching materials, honey and waxes as the major provisioning services and tourism as the main cultural service. The study asserts that the provisioning and cultural services provided by the Sundarban contributed to the revenue of the Forest Department on an average of $744,000 and $42,000 per year respectively in ten years (during 2001–2002 to 2009–2010). This amounts to USD 1.39 per hectare per year for the entire forest. We think, that the revenue of the produce (i.e. the tangible outputs) is probably a gross under-valuation of the services; keeping in mind that timber and tourism prices are regulated.

Table 6.3: Summary of the Values from Other Studies

Sl No.	Author (year)	Study description	Ecological Services	Other info	Value range (US$/ha/yr)
a.	Costanza, *et al.*, 1997	Value of Capital stock + ES of Mangrove.	17 ecosystems of 16 biomes in total.	1.83 times of planetary GNP	$9,990 – $19,580
b.	Groot, *et al.*, 2012	Global value estimated of Oceanic ES	Total 10 biomes including 300 cases selecting 665 values. Out of which 139 coastal wetlands estimates.	The coastal wetland values are the most relevant since it includes mainly mangroves	$300 – $887,828 (median = $12,163
c.	Brander, *et al.*, 2012	Ecosystem service values for mangroves in Southeast Asia	130 value estimates over all mangroves of Southeast Asia	Mean>median value indicating the curve to be skewed to the left. This also means that 50% of the 130 values has a value greater than US$239/yr/ha	Mean value = $4185 (Median value =$239) =$229.45 (marginal value for coastal protection)

Sl No.	Author (year)	Study description	Ecological Services	Other info	Value range (US$/ha/yr)
d.	Uddin, Steveninck, Stuip, & Shah, 2013	ES valuation of SRF in Bangladesh	Provisional + cultural services: Provisioning services: Timber, fuel-wood, fish, thatching, honey and wax Cultural services: Tourism	The revenue provided by the provisioning and cultural services of the Sundarban USD 744,000 and USD 42,000 per year; respectively.	$1.31
	This study using Delphi Method		9 Support + 7 regulatory + 5 provisional + 3 cultural + waste treatment, water regulation and a few others		$105.07 – $840.59

a http://www.nature.com/nature/journal/v387/n6630/full/387253a0.html
b http://www.sciencedirect.com/science/article/pii/S2212041612000101?np=y
c http://www.sciencedirect.com/science/article/pii/S2212041612000101?np=y
d http://www.sciencedirect.com/science/article/pii/S2212041613000491?np=y

6.7 Conclusion and Value of the Sundarban Ecosystem Services

In total, estimates of values using the Delphi approach was used for 9 support functions, 7 regulatory, 5 provisional and 3 cultural services. Result shows that the value of ecosystem services per ha of land in Sundarban per year found to vary between $105 and $840. In addition to the services included in the list, a mangrove ecosystem also provides two additional and important services. These are a) storm protection services and b) coastal protection services. Brander *et al* (2012) in their meta-analysis from 130 different studies found that on average 229.45 is the value of coastal protection services per ha per year from a mangrove ecosystem. A study on the protective value of mangrove during super cyclone in Odissa estimated a value of $1,218 per ha. This value can be also added to the estimated value as the value for protection of mangroves from cyclones. (Das, 2009). However, it only includes property damages. At the same time, assuming 1:10 as the probability of cyclone in coastal areas of Bangladesh, the value for the Bangladesh Sundarban is around $121.8 per ha per year.

Therefore, our estimate is that mangroves of the Sundarban generate a services worth between $456.32 to $1,191.84 per hectare per year or $273 to $714 million per year for the entire Sundarban. This value is compatible when we look at the values provided in the different studies dealing with values of mangrove ecosystem services (Table 6.3 above). Because of the large degree of uncertainties related to ecosystem services the range of values is very large. Groot, *et al.*, (2012), for example, observed that the value varies from as low as $300 per ha per year to nearly $887,000 per ha per year.