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Update of Estimated Agricultural Benefits Attributable to Drainage and Flood Control in Willacy County, Texas

Raymondville Drain

Static and Stochastic Implications

**Prepared for the U.S. Army Corp of Engineers
Galveston, Texas**

by

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Acknowledgements

This evaluation is an update of an earlier study for the South Main and Raymondville Drain in Willacy County. Therefore, we remain indebted to the efforts of a team where each contributed in their area of expertise. The Corps of Engineers provided much of the basic information as soils and the study area while the Texas Agricultural Experiment Station updated the economic model, applied it and interpreted the results. The spirit of a cooperative agreement is fulfilled when there is a vested contribution by both the Corps of Engineers and Texas Agricultural Experiment Station. The mission of both is addressed.

Much of the base model data were generated through focus groups comprised of the leaders in the study area. We are indebted to them for their generous allocation of time.

Executive Summary

This report represents an update on the 2001 evaluation of benefits attributable to the South Main Drain in Willacy County. The results are limited to agricultural benefits due to reduced flood damages and improved drainage. The ABE model was updated to reflect current inputs and associated costs as well as the normalized prices. The 2006 Texas Cooperative Extension crop enterprise budgets were used to update the crop budgets in the ABE model. Since 2001, the costs have increased and normalized prices are dramatically less. The means that the expected benefits of the Raymondville Drain are substantially lower. In addition, the current discount rate of 5.125% was applied to calculate present value over the 50 year planning horizon.

The first sections of this report are a repeat of the base data. However, the soils and expected yields with applicable acres for each were developed just for the Raymondville Drain area of study. This study area information is presented initially in the report. Some of the highlights of benefits are presented in this summary.

Static Analysis

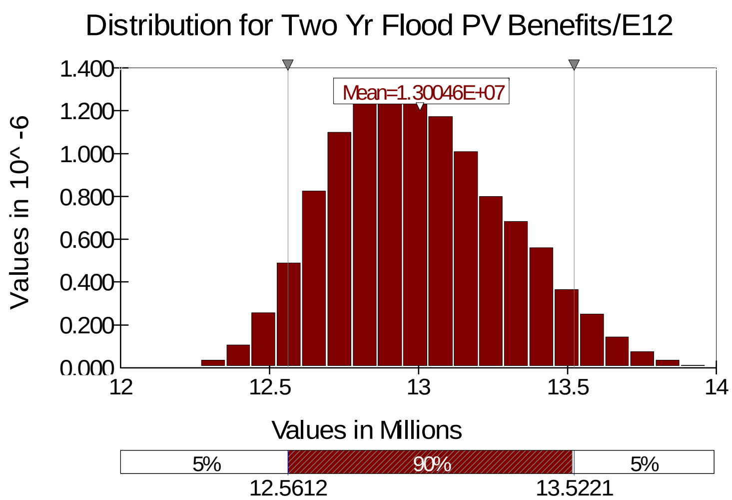
For the static analysis, the total per acre benefits and the present value over a 50 year planning horizon were estimated. The results are as follows:

	Flood Frequency		
	50%	20%	10%
Average Annual Benefits (thou $)	726	854	968
Present Value of Benefits (mil$)	13.00	15.30	17.34

This suggests that for the static analysis the benefits for on an average annual basis are $726 thousand for the 50% rainfall event, $854 thousand for the 20% event and $968 thousand for the 10% event. The present value of benefits for agriculture across all acres is $13 million for the 50% occurrence event, $15.3 million for the 20% event and $17.3 for the 10% event. The benefits of a project that protects from the 10% rainfall event are over four million dollars greater than for the 50% event. This is nearly a 25% increase in benefits.

Stochastic Analysis

Using the range in probabilities provided by the focus group sessions in the study area, the ABE model was applied under @Risk to generate a range of benefits and associated likelihood. The results of the stochastic analysis are presented in graphical form as a cumulative distribution. In reviewing the graphs below, the expected benefits of the 50% rainfall event would be between $12.6 and $13.5 million 90% of the time. Similarly, for the 20% event, the 90% range in benefits is from $14.8 and $15.9 million. The 90% increment, for expected benefits for protection at the 10% event level, ranges from $16.8 and $18 million.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1.000
0.800
0.600
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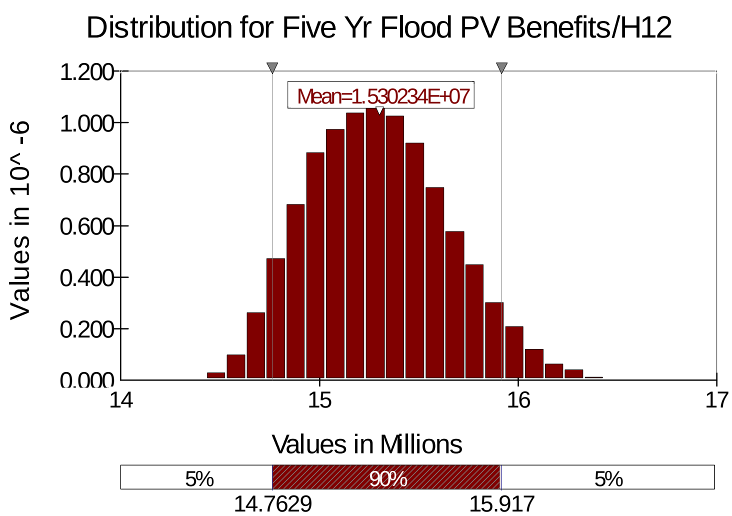
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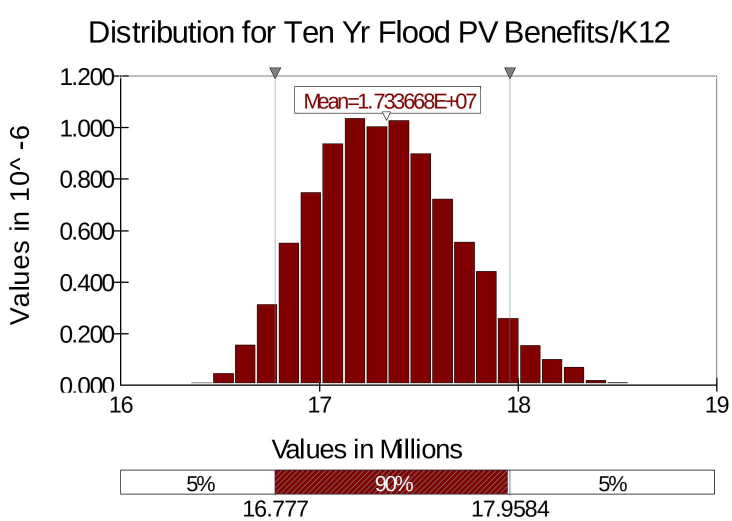
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16
17
18
19
Values in Millions
5%
90%
5%
16.777
17.9584

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INTRODUCTION

Purpose

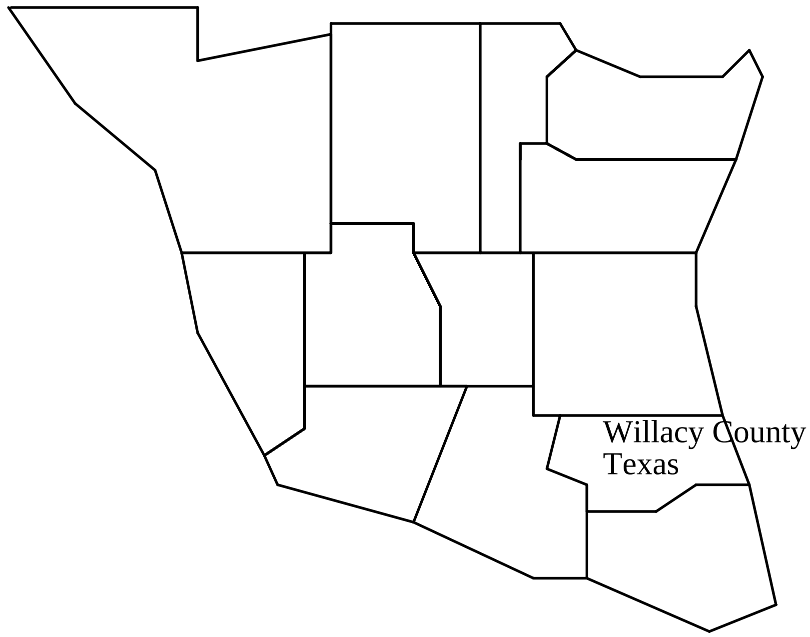
This study presents an economic analysis of agricultural benefits attributable to a proposed drainage project which includes on farm systems, laterals (ditches) and major canals designed to lower the groundwater table and provide an outlet for floodwater from agricultural land in Willacy county, Texas as provided by the Raymondville Drain. There are benefits to the urban communities that are not included in this update.

BACKGROUND

Willacy County is located in the Lower Rio Grande Valley in the southern-most tip of Texas (see Figure 1). Crop production is carried out under irrigated and dryland (rainfed) conditions. The region is relatively flat and near sea level. This results in both a high exposure to flooding and a water table near the soil surface in many parts of the study area. The two problems are linked in that any reduction in flooding has an impact on the depth of the water in the soil profile. Thus, the high water table (HWT) and flooding potential cannot be addressed separately. The water table is saline, resulting in crop yield losses on HWT acreage.

In 1982, the U.S. Army Corps of Engineers (U.S. Army COE) conducted a study to assess the benefits and costs associated with expanding drainage infrastructure in Hidalgo and Willacy counties to achieve the joint objective of flood control and lowering the HWT (U.S. Army COE, 1982). Economic benefits and costs of building structures were assessed to mitigate against damages to urban and agricultural lands from flooding and salinity problems associated with HWT. The 1982 estimate of benefits over the expected life of the project from expanding the drainage infrastructure in Hidalgo and Willacy counties were $86 million discounted to a present value basis. The estimated benefit-cost ratio was positive at 2.88. Though approved, no funds were appropriated to initiate the project and the results from the economic assessment expired seven years after the completion of the study, that is, in 1989. An update in 2001 for Willacy County has since expired, thus this update for the Raymondville Drain.

Figure 1. Willacy County, Texas



In the early 1990s there was renewed interest in a project to expand the drainage infrastructure in Hidalgo and Willacy counties. The Lacewell, et al. (1995) report is one component of a comprehensive study that was done to reassess the economic and technical feasibility of the proposed project to improve flood control and drainage in Hidalgo and Willacy counties. The analysis reported in Lacewell, et al. (1995) focused on agricultural benefits from improved drainage and flood control.

Literature Review

Important precursors to this analysis for Willacy County includes the Lacewell, et al. (1995) report and the U.S. Army Corps of Engineers' 1982 assessment of improved drainage infrastructure for Hidalgo and Willacy Counties (U.S. Army COE, 1982). The Agricultural Benefits Estimator (ABE) model was developed for a similar study for Cameron County -- an area adjacent to Hidalgo and Willacy counties -- conducted in 1989 by researchers at Texas A&M University collaborating with U.S. Army COE economists and Soil Conservation Service personnel (Lacewell et al., 1989). ABE was also applied for revaluation of agricultural benefits attributed to drainage in the Arroyo Colorado. For a concise description of the results of the Cameron County study, see Robinson et al., (1989) and for a complete description of the ABE model see Lacewell and Freeman (1990). The ABE model was modified for the specific conditions of the Raymondville Drain study area and applied for this evaluation.

CHARACTERIZATION OF AGRICULTURE

To estimate benefits of the drainage project, the ABE model requires a cropping pattern for existing conditions and with project conditions, along with crop yield in each case. This section discusses cropping patterns, basic soils, the base cropping pattern, and crop yields of Willacy County developed for the analysis.

Agricultural production refers primarily to acres of different crops. It was necessary to quantify cropping patterns for the study area to relate reduced damages to specific crops. Statistics on agricultural production applicable to Willacy county were used to establish the cropping pattern as given in Texas Department of Agriculture (1998) along with the percent allocation for each crop (dryland and irrigated). Interviews with scientists in the region suggest that there have been no significant changes in cropping patterns for Willacy County.

Soil Groups and Productivity

Detailed soil maps, classifications, productivity and yield information are available in the "Soil Survey of Willacy County, Texas" (USDA, SCS, 1982). The published Soil Survey for Willacy County outlines the extent of each soil series along with its expected productivity under high level management.

Soils

This update of agricultural benefits for drainage and flood control as related to the Raymondville Drain in Willacy County required that The Corps of Engineers digitize the soils maps for the area. Utilizing the digitized data, the incidence of each soil in the Raymondville Drain was quantified by David Petit of the COE. This information is detailed and enabled a more accurate representation of the area's agricultural productivity. Table 1 presents acreage and percentages of the soils occurring in the Raymondville Drain area of study. There are 43 soils in Willacy County. The major soils include Lyford Sandy Clay Loam (15.6%), Lozano fine Sandy Loam (13.1%), Raymondville Clay Loam (11.6%), Hidalgo sandy clay loam (6.0%), and Willamar fine sandy loam (8.7%).

Table 1. Acreage and proportion of the soils of the Raymondville Drain study area

Symbol	Soil Name	Acres	Percent
An	Arents, loamy	73.6	0.084939
Ar	Arrada sandy clay loam	744.5	0.859659
Ba	Barrada clay	27.1	0.031292
DeA	Delfina loamy fine sand, 0 to 2 percent slopes	702.1	0.810698
Dn	Dune land	736.9	0.850911
FaB	Falfurrias fine sand, gently undulating	2966.9	3.425677
GaB	Galveston fine sand, gently undulating	1440.5	1.663298
GmB	Galveston-Mustang complex, gently undulating	1980.0	2.286154
HgB	Hidalgo fine sandy loam, 1 to 3 percent slopes	207.7	0.239815
HoA	Hidalgo sandy clay loam, 0 to 1 percent slopes	5232.2	6.041367
Ic	Incell clay	1535.0	1.772351
Ja	Jarron sandy clay loam	2026.4	2.339744
LaB	Lalinda sandy clay loam, 1 to 5 percent slopes	154.6	0.178553
Le	Latina sandy clay loam	1254.9	1.449002
Lm	Lomalta clay	253.5	0.292656
Ln	Lozano fine sandy loam	11321.2	13.071880
Ly	Lyford sandy clay loam	13518.2	15.608680
Me	Mercedes clay	2393.5	2.763644
Mp	Mercedes clay, ponded	1261.7	1.456803
Mu	Mustang fine sand	481.5	0.555976
Nu	Nueces fine sand	2453.0	2.832357
Po	Porfirio sandy clay loam	583.8	0.674119
Ra	Racombes sandy clay loam	4194.0	4.842514
Rc	Racombes sandy clay loam, saline	993.9	1.147644
Rd	Raymondville clay loam	10014.6	11.563290
Re	Raymondville clay loam, saline	44.8	0.051691
Rf	Rio fine sandy loam	52.1	0.060134
Rg	Rio sandy clay loam	735.2	0.848935
Rs	Rio sandy clay loam, saline	125.2	0.144612
SaB	Sarita fine sand, gently undulating	861.8	0.995100
Ss	Saucel sandy loam	1385.0	1.599210
Su	Sauz fine sand	4036.6	4.660809
Sz	Sauz loamy fine sand	1045.9	1.207688
Ta	Tatton fine sand	6.3	0.007277
Tc	Tiocano clay	467.1	0.539341
Uf	Ustorthents, loamy	14.3	0.016559
W	Water	305.9	0.353231
WaA	Willacy fine sandy loam, 0 to 1 percent slopes	2335.9	2.697160
WaB	Willacy fine sandy loam, 1 to 3 percent slopes	701.0	0.809436
Wf	Willamar fine sandy loam	7567.5	8.737701
Ws	Willamar fine sandy loam, strongly saline	147.4	0.170206
Yf	Yturria fine sandy loam	223.3	0.257887
	TOTAL	86606.9	100

Source: US Department of Agriculture, Soil Conservation Service. Soil Survey, Willacy County as digitized by David Petit of the U.S. Army COE.

Soil Productivity

In the Soil Survey, an expected yield by soil is presented assuming high level management, no flooding, no insects, no weeds, etc. This is valuable information for establishing potential yields to be applied in ABE. The soils for the Raymondville Drain study area were divided into relatively homogeneous groups. Then within each group, using the yield data, a group yield by crop and for irrigated and dryland was established.

Soil Groupings

The soils in the study region were combined into groups with similar crop yields. Some of the land area is not suitable for crop production. All land not suitable for crop production or unaffected by the proposed project was assigned to group I. The acres of land applicable to each of the broad groupings (I-VII) are given in Table 2. For the soil groupings, the lower productive soils are in first groups while the more productive soils are in the upper groups. The acreage distribution is based on the digitized soil maps developed by David Petit of COE for the Raymondville Drain region. The soil groupings show a larger proportion of soils in groups VI and VII indicating a productive region with a great potential. In the grouping process, the basic structure of ABE was considered where there was a typical or expected yield. The yields from the soil survey provided the basic information for groupings. Once the soil groups were established for the Raymondville Drain area, a weighted average yield was calculated for each agricultural crop in each of the groupings. This was done by multiplying the yield by acres of each soil type in a group, summing and then dividing by total acres. Soil Group I suggests no agricultural production due to either urban or under water or unproductive soils.

Land Use Study

The analysis of land use for this study involved soil classification, agricultural land classification, and the cropping pattern. The information was used to develop the composite acre format used in the benefit analysis. To apply the ABE model it was necessary to establish total acres and then define acres irrigated, acres dryland and other acres. In addition, the land had to be further defined into acres of each crop under irrigation and under dryland production. The study area is well defined with acres, soil types and expected yield on each soil type. The distributions for irrigated and dryland and percent of each crop used the Willacy County statistics.

Table 2. Acres applicable to each soil grouping, Raymondville Drain

Soil Group	Acres	Percent
I	8,619	9.95
II	13,756	15.88
III	584	0.67
IV	11,184	12.91
V	1,489	1.72
VI	35,777	41.32
VII	15,197	17.55
Total	**86,607**	**100.00**

Classification of Agricultural Land

To address land for agriculture in the Raymondville Drain, the 1998 Texas Agricultural Statistics was used (Texas Department of Agriculture, 1998). This report of statistics provided a percent division for land irrigated, land produced dryland and pastureland to use in the ABE model. In addition, a cropping pattern based on the percent of irrigated land in each of the crops and percent of each of the crops in non-irrigated production was used based on the 1997-98 cropping statistics. These are presented in Table 3. Again the acres in the study area were established by the digitized soil maps so just the Raymondville area is included but the land use pattern from County Statistics provided the basis for allocating acres in the study area.

The high water table (HWT) in Willacy County is significant. All acres that had a water table 48 inches or closer to the soil surface, as identified by the Soil Survey, were included. Acres with a water table 48 inches or closer to the surface sometimes incur a soil salinity problem; the nearer the water table to the soil surface the more severe the salinity problem. Approximately 11.6 percent of the acres in the study area had a water table 48 inches or closer to the soil surface as identified in the Lacewell, et al. (1995) report. These acres represented the estimate of HWT acres where the project would be expected to reduce damages.

Cropping Pattern

The cropping pattern refers to the distribution of acres planted to each crop, accounting for irrigation and rotation patterns. Crops are normally grown year-around in the South Texas Region. Crops are rotated for the subsequently favorable yield effects and to control disease, weeds, and insects.

Table 3 summarizes the cropping pattern for Willacy County. The cropping pattern is based on the Texas Department of Agriculture Crop Statistics (1998). With drainage, there will be field facilities and channels that go to the Gulf of Mexico, which will result in the water tables being lowered. With the project, there are saline soils that over a period of three to five years would decrease in salinity (Lacewell et al., 1990). These soils would be brought into higher value crop production with the project and are assumed to go out of dryland pasture. For this reason, crop acres increase and dryland pasture decrease with the project.

Potential Crop Yields

With quantification of the acres of each crop (irrigated or dryland), a composite acre was constructed for each crop, dryland and irrigated, that represented the proportion of each soil group applicable to production of that crop in the Raymondville Drain study area. Some soil groups are only applicable for dryland or for irrigated production for selected crops. The composite acre format gives a one acre representation of the mix of soils in the study area, applicable to each crop and with each soil group having the same proportion to each other as for the study area as a whole. This proportionate allocation of soil groups, by crop, was used to estimate weighted yield for each crop, capturing the various productivities and applicability's (i.e. irrigated and dryland) of those soils. Soil Group I is urban land, water and non agriculture soils so there are no yields.

Table 4 is an illustration of the calculation for irrigated cotton under existing conditions. Irrigated cotton is not grown on three of the soil groups. In this case, the per acre weighted existing potential yield for irrigated cotton was a computed value of 854.72 pounds of lint per acre. This procedure was followed for all crops except corn. Information on corn yield is not available in Willacy County Soil Survey. Therefore, the same procedure which was used to calculate corn yield in Cameron County Study (Lacewell et al., 1989) was followed. Corn yield in Cameron county was set at 2.17 bushel (bu) times sorghum in hundredweight (cwt) based on a three year average. This means one cwt of sorghum can be used to estimate a corn yield of 2.1711768 bu.

Table 3. Estimated cropping pattern Willacy County

Crop	Percent
Irrigated	4.40
Pasture	19.20
Cotton	20.80
Sorghum	18.80
Corn	14.40
Sugarcane	18.40
Citrus	4.00
Onions	100.00
Total Irrigated	
Dryland	
Cotton	42.66
Sorghum	57.34
Total Dryland	100.00
Pasture (Dry)	3.90
Diverted	0.00

Source: Texas Department of Agriculture (1998).

Table 4. Example of estimating weighted potential irrigated cotton yield under existing conditions, by soil group productivity, Raymondville Drain

Soil Group	Proportion of Total	Yield (lbs. lint/acre)	Weighted Yield (lbs. lint/acre)
I	0.0000	0.00	0.00
II	0.0000	0.00	0.00
III	0.0000	0.00	0.00
IV	0.1757	361.00	63.44
V	0.0234	713.00	16.68
VI	0.5621	901.00	506.46
VII	0.2388	1123.00	268.14
Total	1.0000		
Weighted yield			854.72

Source: Soil Survey (Willacy counties), Texas.

Potential crop yields in the absence of any flooding were assumed the same with or without the project. Table 5 presents a summary of potential crop yields under existing conditions (assuming no HWT or flooding losses). Expected losses to a HWT and flooding were applied to these yield values.

Table 5. Weighted potential crop yields per acre for Raymondville Drain

Crop	Unit	Yield
Irrigated		
Cotton	lbs	854.7
Sorghum	cwt	54.5
Corn	bu	118.33
Sugarcane	tons	44.4
Citrus	tons	23.2
Onions	bags	368.9
Pasture	aum	10.9
Dryland		
Cotton	lbs	356.9
Sorghum	cwt	27.9
Pasture	aum	3.9

FLOOD LOSS ESTIMATES

Historically, periodic flooding in the study area has resulted in significant crop yield losses. Due to the relatively flat terrain, similar to Cameron County, typical damage factors and use of cross sections were not applicable to the Raymondville Drain. By applying the ABE model, the crop losses due to periodic flooding based on a farmer survey and use of focus groups in the South Main (that included Willacy County) were used. In addition, through the focus group process, the expected losses due to a high water table were quantified. Lastly, additional costs associated with flood damage were identified by the focus groups and included such things as delayed harvesting, extra field operations, loss of crop stand or impact on germination, replanting and releveling. These costs are incorporated into the ABE model.

Focus Groups

The Focus Group approach is being used increasingly to efficiently collect data. This approach was selected to obtain reliable, quality data in a timely manner. Focus group participants are selected to represent well-informed producers. Through a nominal group process, the participants develop a profile of a "prototypical" agricultural production situation. For a description of the methodology, refer to Pagano, 1993.

Three separate meetings, or Focus Groups, were organized consisting of (1) irrigated crop, (2) fruit and vegetable, and (3) dryland crop producers. The participants were selected with the assistance of Noe Garza, Natural Resource Conservation Service District Conservationist for

Hidalgo County, Vona Walker, Director, Hidalgo County Right of Way Department, Jim Riggan, Supervisor, Willacy County Drainage District, and Brad Cowen, Hidalgo County Extension Agent. Jose Amador, former resident director of Texas A&M University Research and Extension Center in Weslaco, Doyle Warren, former District Agent for Extension Service in Weslaco, and Ruben Saldana, Willacy County Extension Agent.

Invitations to the Irrigated Crop, and Fruit and Vegetable Focus Group meetings were extended by telephone to each potential participant. As a follow up measure, Lacewell sent letters containing time, date, location, and a brief schedule to the producers who indicated an interest in the process. Riggan made all arrangements, including participant selection and communication, for the Dryland Crop Producers Focus Group.

The goal of the Focus Groups was to provide yield loss estimates for each crop at different stages of crop production and varying flood levels. Overhead transparencies were used to facilitate, guide, and record the activities of the Focus Groups. In addition, an audio cassette recorder was used to record the data in case of confusion in written worksheets developed during the meetings. The Focus Groups were asked to respond assuming conditions before the Main Drain was constructed (Hidalgo and Willacy County Drainage Districts passed a bond issue and constructed a drainage ditch several years ago).

The first Focus Group meeting, irrigated crop producers, was held June 8, 1994 at 10:00 A.M. in the Hidalgo County Building in Edinburg, Texas. Five producers participated: Wayne Bonham, Manuel Ortega, Jesse Russell, Aron Shield, and Jimmy Steindinger. There were several observers: Jerry Kazda, of the Natural Resource Conservation Service, Temple, Roger Freeman, of the Army Corps of Engineers, Galveston, John Robinson, of Texas Agricultural Experiment Station, Weslaco, Merritt Taylor, of Texas Agriculture Extension Service, Weslaco, and John Shepperd of Texas A&M University, College Station.

Purvis was responsible for conducting the formal data collection phase of the Focus Group meetings. The producers were shown two overhead transparencies for each crop. The first transparency was designed to collect the flood loss information, and the second, high water table damages. Table 6 shows the overhead transparency for irrigated cotton.

To keep the process as flexible as possible, the overhead transparencies were structured to be simple and straightforward. A breakdown of the different crop growth stages (the vertical columns), was provided. Producers were told, however, that they may alter the growth stages if they, as a group, saw fit.

Table 6. Example of transparency used to facilitate data collection from Focus Groups

Irrigated Cotton--Most likely losses						
Rainfall Level	**Prep & Planting**	**Early Growth**	**Maturity & Harvest**	**Off-Season**		
3-4 inches 1 yr flood						
4-5 inches 2 yr flood						
5-7 inches 5 yr flood						
7-9 inches 10 yr flood						
9 + inches 25 yr flood						

Average yield per acre = 990 pounds

The producers provided the months during which each growth stage would normally occur. For example, "Preparation and Planting" occurs during February and March; "Early Growth" occurs from April to July, and so forth. The producers felt that "Early Growth" of irrigated cotton should be broken down into early growth after irrigation, and early growth before irrigation. Once the crop had been irrigated, a flood would cause greater damage than if the crop had not yet been irrigated. Thus, the column "Early Growth After Irrigation" reflects greater damages than "Early Growth Before Irrigation". Irrigated Cotton was the only crop broken down in this fashion. The stages of crop production varied by month for each particular crop.

After the growth stages were assigned specific months, the process of developing flood loss damages began. Producers were asked to estimate the expected percent yield reduction by crop for each flood size occurring during various stages of the crop production process. This information was requested because damages were hypothesized to vary depending on the stage of crop production. For example, a flood during the "Off Season" wouldn't cause equal damage as the same size flood during the "Early Growth" period. The producers provided estimates for five different flood sizes and the corresponding effects on nine different crops during different stages of production.

Finally, an estimated average yield per acre for each particular crop, obtained from the Soil Conservation Service Soil Surveys for Hidalgo and Willacy counties, was verified by the producers. They were asked to correct this data if necessary. Table 7 shows a sample of a completed overhead transparency as collected from the producers in the first Focus Group meeting. Appendix A presents the detailed crop yield loss data for each crop as developed in the three Focus Group meetings and is a part of the ABE model.

Three percentages were collected for each cell, representing the "low", "most likely", and "high" values. For example, a seven to nine inch rainfall during Maturity and Harvest was estimated to cause between 60% and 80% loss in production, with 75% being the most likely value. The three values were collected to facilitate the @RISK modeling procedure; the values were entered into the program as a triangular distribution.

As greater floods occur, the producers reported that damages to crop yields increase due to the larger rainfall event, greater depth of inundation and length of time water stands in the field. This Focus Group provided average yield loss estimates for all acres of each crop rather than just the acres susceptible to flooding. The second Focus Group meeting was held in the Hidalgo County Building at 4:00 PM on June 8, 1994. Three producers participated in the afternoon session: Bobby Lackey, Bill Thompson and Tommy Thompson.

There were several observers: Jerry Kazda, Roger Freeman, John Robinson, Merritt Taylor, and John Shepperd. The meeting began with a brief introduction by Ron Lacewell and Amy Purvis, followed by the same format as the first meeting. The Focus Group was asked about the fruit and vegetable crops: melons, onions, and grapefruit.

The third Focus Group meeting was held June 9, 1994 at the Willacy County Drainage District Office in Lyford, Texas at 9:30 A.M. Jim Riggan organized the meeting which included seven dryland crop producers: Jerry Taylor, Joe Pennington, Gary Palonsek, Bill Calvin, Manuel Garcia, Bob Ed Stewart, and Glen Wilde. Juan Pena of the Raymondville Field Office of the Natural Resource Conservation Service was present as an observer, in addition to Jerry Kazda, Roger Freeman, John Robinson, Merritt Taylor, and John Shepperd.

Table 7. Completed transparency collected during irrigated crop producers Focus Group

Irrigated Cotton--Most likely losses						
Rainfall Level	**Prep & Planting (Feb-Mar)**	**Early Growth Before Irrigation (April-July)**	**Early Growth After Irrigation (April-July)**	**Maturity & Harvest Last week of (July-Aug)**	**Off-Season (Sep-Dec)**	**(Jan)**
3-4 inches 1 yr flood	0	0	25%	50% 30-50%	0	0
4-5 inches 2 yr flood	0	0	25%	60% 30-60%	0	0
5-7 inches 5 yr flood	10%	10% 10-15%	25% 20-30%	60% 30-60%	5% 0-10%	0
7-9 inches 10 yr flood	25%	25% 20-30%	30% 25-30%	75% 60-80%	12% 10-15%	10%
9 + inches 25 yr flood	55% 50-60%	55% 50-60%	65% 50-80%	100%	15% 10-25%	30% 25-40%

Average yield per acre = 990 pounds

The basic format of the first two meetings continued, the producers supplying figures for dryland cotton and sorghum. After the meeting, the group toured part of the Parnell Ranch to observe the South Main Ditch firsthand, and some surrounding agricultural areas.

To eliminate future confusion about the data collected from the Focus Groups, Purvis, Lacewell, Shepperd, and Kazda met twice within the following week to consolidate the information. At this time, decisions were made to not include some data in the model as it was determined the damages were due to rainfall, rather than flooding. Specifically, heavy rainfall can affect date of market entry of melons and grapefruit. While this undeniably is costly to the producers, damages are due to rainfall itself, rather than flooding, which means a flood control project would not have any effect in this case.

Procedure for Weighted Yield Loss Estimates

Since the detailed seasonal damage loss information collected from the Focus Groups exceeded the capability of the ABE model, the study team of Freeman, Kazda, Lacewell and Purvis elected to calculate a weighted annual crop loss figure for the low, most likely and high estimates by flood size. This was based on probability of flooding.

The Texas State Climatologist's Office provided rainfall data from the seven National Weather Bureau weather stations located in McCook, McAllen, McAllen Airport, Mission, Port Mansfield, Raymondville, and Weslaco.

To calculate rainfall probabilities, all events during a 24-hour duration equal to or greater than 3 inches were compiled and summarized by month. Then, the total for each month was divided by the sum of all rainfall events (equal to or greater than three inches.)

For example, to find the probability of a rainfall event during January, Table 8 shows that eight events of three of more inches have occurred between 1910 and 1992. Eight is divided by 255, the total number of events, which equals .03137255, or 3.14%. Table 8 illustrates the rounded probabilities of any rainfall event greater than or equal to three inches occurring during a specific month, to the nearest ten thousandth.

Table 8. Probability of a rainfall event of three inches or more by month, Lower Rio Grande Valley, Texas

		Probability
January	8	0.0314
February	6	0.0235
March	1	0.0039
April	17	0.0667
May	42	0.1647
June	33	0.1294
July	8	0.0314
August	27	0.1059
September	68	0.2667
October	39	0.1529
November	5	0.0196
December	1	0.0039
TOTAL	**255**	**1.0000**

Source: Texas State Climatologist’s Office.

The probabilities of a specific flood event during a particular stage of crop production were used to calculate a weighted yield loss for various crops. For example, referring to Table 20, during Preparation and Planting of irrigated cotton, the producers estimated the flooding from a 5-7 inch rainfall would "most likely" cause a 10% reduction in crop yield. (In this case, there was not a "low" or "high" estimate provided.) Table 8 reports the probability of a large rainfall occurring during the months of Preparation and Planting, which are February and March for irrigated cotton. The rainfall probabilities of each month are added together: .0235 + .0039 =

.0274. This sum is multiplied by the producers damage estimate from a 5-7 inch flood during this stage of growth; it is 10% in this case (10% X .0274 = .274%). This is the weighted yield loss for irrigated cotton, during Preparation and Planting, from a flood resulting from a 5-7 inch rainfall.

The second stage of irrigated cotton is "Early Growth," which occurs from April to July. As previously mentioned, the irrigated producers reported two scenarios for this growth stage. The first column lists flood damages occurring if the field had not yet been irrigated; the second is damages that would occur if the field had already been irrigated. To obtain the "most likely" weighted loss of a five year flood during Early Growth before irrigation, once again the probabilities of a large rainfall event happening during the time period April to July: .0667 + .1647 + .1294 + .0314 = .3922 (or 39.22%). This sum is multiplied by the producer's estimate of yield losses, which happens to be 10% again. The result, 3.922%, is the "most likely" weighted yield loss of irrigated cotton during the early growth period before irrigation from a five year flood. The weighted yield loss is then calculated for the next stages of crop production, which are Maturity and Harvest, Off Season, and January in this example. The results are summed across the rows, and the end result is a single value representing the weighted annual yield loss for the crop for that particular flood event. The same procedure was used to calculate the "low" and "high" yield losses. If the producers gave only a single value for a particular yield loss, this value was considered to be the "low", "most likely", and "high" yield loss. For the 2001 report the values are presented in Table 9 of that report.

Acres that Flood

The ten year, or ten percent probability, storm was estimated to flood 90.8% of the acres on irrigated land and 32.2% of dryland acres that would be flooded by a twenty five year storm. The five year storm (twenty percent probability) would flood 72.9% of the irrigated, and 29.5% of the dryland acres; the two year storm (fifty percent probability) would flood 33% of the irrigated, and 12.2% of the dryland acres. And, the one year storm (one hundred percent probability) would flood 24.5% of the irrigated, and 2.9% of the dryland acres that would be flooded by a 25 year storm. The breakdown of land flooded by storms below the four percent probability is based on the farmer surveys of Hidalgo, Willacy and Cameron counties. This general relationship was applied to the Raymondville Drain Study Area recognizing it is an approximation.

High Water Table Yield Losses

A high water table (HWT) is defined as a water table 48 inches or less beneath the soil surface. This is a common occurrence in both Hidalgo and Willacy counties, and significantly affects crop yields.

Soil Group II designates soils that have a high water table and salinity problem. Because of this, a yield increase with drainage is applicable only in this soil group. With project conditions, 4,600 saline acres in Group II were converted to cropland and allocated across crops in the same proportion as existing (before project) conditions. The temporal analysis incorporates a five year desalting period where yields go from very low to a non-saline condition. The land area remains vulnerable to a high water table, but drainage reduces annual expected damages to five percent of yield.

The yield loss from HWT is a major factor in agricultural production. The Focus Groups provided estimates of the percent yield reduction, by crop, in those areas suffering from a HWT. Table 9 shows the information collected from the Focus Groups.

Table 9. Expected annual percent yield reduction, by Crop, on acres vulnerable to HWT

	Percentages		
IRRIGATED	Low	Most Likely	High
Cotton	0	30	100
Sorghum	0	40	100
Corn		Not grown on HWT soils	
Sugarcane		Not grown on HWT soils	
FRUITS AND VEGETABLES			
Melons		Not grown on HWT soils	
Onions		Not grown on HWT soils	
Citrus		Not grown on HWT soils	
DRYLAND			
Cotton	35	40	100
Sorghum	30	50	100

Source: Focus Group Meetings.

ADDITIONAL COSTS ATTRIBUTABLE TO FLOODING

The initial costs of crop production were developed with Texas Agricultural Extension Service data. The costs include seed, pesticides, fertilizers, machine operations, irrigation water, labor, harvesting, hauling, and other inputs. Flooding causes damages and results in expenses other than crop yield loss; these costs need to be included in the analysis to obtain an accurate estimate of flood protection benefits.

This added cost information came from the Focus Groups, as well. After the overhead for each crop was completed, the producers were asked what additional costs are incurred from flooding. Their response was recorded on a second overhead, as in Table 10 below. This exhibits the additional cost data associated with flood damage for irrigated cotton. Similar information was obtained for all crops included in the study.

The procedure for calculating weighted additional costs is identical to that of weighted yield losses except the producers provided the data in dollar values per acre instead of percentages. Each cost is multiplied by the probability of the flood event during the particular stage of crop production, and then added across the year to get the weighted dollar value per acre. Table 10 shows the weighted additional costs as collected from the producers.

Acres of each crop with a HWT that are expected to flood with each flood size were quantified by the focus groups and were tailored to Willacy County.

Table 10. Example of transparency for additional costs attributable to flooding

Additional costs associated with flood damage for irrigated cotton

1. During harvest (August), flooding from rainfalls greater than 7" will delay field operations. This imposes costs of $15/acre.

2. During maturity and harvest (August) a pesticide application is necessary at $15/acre (includes aerial application). A second application is necessary at rainfall levels greater than 5".

3. Also during August, flooding from rainfalls greater than 5" will cause seed damage by killing germiplasm. This costs $10-15/acre. A half grade loss in cotton quality also occurs at $10-15/acre.

4. Releveling is necessary after flooding due to any rainfall event greater than 7" at anytime of year. Approximately 50% of total acreage will need re-leveling at $50/acre.

5. Replanting may be necessary during February -March due to the following rainfall events:

3-4"	10-30%	20% most likely
4-5"	10-30%	20% most likely
5-7"	10-30%	25% most likely
7-9"	30-50%	40% most likely
9+"	40-100%	60% most likely

Replanting costs $35/acre.

Source: Focus group meeting.

Table 11. Weighted additional costs associated with flood damages (dollars per acre)

Rainfall Level	Irr. cotton	Irr. sorghum	Irr. corn	Onions	Citrus	Dryland cotton	Dryland sorghum
3-4 inches 1 yr flood	.19	0	0	34.12	0	3.79	0
4-5 inches 2 yr flood	1.78	0	.27	34.12	0	9.81	0
5-7 inches 5 yr flood	6.07	.67	16.33	159.12	29.95	16.53	2.55
7-9 inches 10 yr flood	32.8	26.04	50.69	199.12	29.95	18.80	2.55
9 + inches 25 yr flood	32.9	26.22	64.64	199.12	29.95	42.48	2.55

Source: Focus group meeting.

METHODS OF ECONOMIC ANALYSIS

The overall purpose in developing cropping patterns, yield, and expected changes associated with flood control (drainage) was to estimate net economic benefits to agriculture. The starting point of the economic analysis was the development of crop enterprise budgets. The economic return information from the budgets could then be applied to cropping patterns to estimate changes in net income to agriculture attributable to the project. Normalized crop prices for 2006 were used in calculating net returns used for estimating the net benefits of the project (US Department of Agriculture, 2006). The prices are presented in Table 12. For this analysis, the ABE (Agricultural Benefits Estimator) model that was used for the South Main study was modified for Willacy County and updated relative to economics. A deterministic analysis provides a point estimate of drainage benefits. However, the analysis was extended to include a stochastic risk analysis by incorporating the @RISK computer program into the ABE model.

Table 12. Crop prices applicable to the analysis

Crop	Unit	Prices
Cotton lint	lb	0.44
Cottonseed	ton	104.30
Sorghum	cwt	3.63
Corn	bu	2.33
Sugarcane	ton	28.54
Citrus	ton	88.88
Onions	bag	16.00
Pasture	aum	12.00

Prices Characteristic: Normalized, U.S.D.A., 2006
Applicable Interest Rate: 5.125%

Source: Economic Research Service (2006) and Robinson (2006).

Enterprise Budgets

Crop and livestock enterprise budgets represent expected costs and returns per unit of an enterprise. For example, a crop enterprise budget for cotton produced with irrigation on a given soil type lists expected yield, type of inputs, quantity and price of each, price of the product (lint and cotton seed), total returns, costs, and net returns per acre. The net return is the foundation for estimating dollar benefits from the project. For this analysis, the base budgets used were developed by Robinson (2006) and published by the Texas Cooperative Extension.

A crop enterprise budget generator is part of the ABE model. Using the 2006 crop enterprise budgets, the budget part of ABE was updated for current levels of inputs and input costs. In addition, a separate returns to land was developed for all yields. Thus, 260 budgets were developed, including budgets for the yield potential, a HWT problem, and a periodic flooding problem for land with HWT and without HWT both under existing conditions and the "with project" condition. Pasture was evaluated on an animal unit month (aum) basis, with expected net returns per aum calculated using Texas Cooperative Extension published budgets.

For the stochastic (with @RISK) analysis, yields were random for each flood size and crop; thus literally millions of budgets (net returns) were estimated during the model application. By having the enterprise budget generator embedded in the ABE model, it was possible to apply @RISK techniques in an efficient manner.

Net Returns Calculations

The enterprise budgets and their associated net returns were generated with a spread sheet program. The enterprise budgets were presented in a standard format. Each crop budget page includes costs and returns for scenarios of 1) no problem, 2) HWT, 3) 100% flood frequency, 4) 50% flood frequency, 5) 20% flood frequency, 6) 10% flood frequency, and 7) 4% flood frequency. The budgets have separate sections for 1) gross returns, 2) variable costs, not including harvesting, hauling, and processing, 3) harvesting, hauling, and processing, 4) total variable costs, 5) returns above variable costs, 6) fixed costs, 7) total costs, and 8) returns to land. For this analysis, returns above variable costs were used as a basis of estimating benefits of the proposed Raymondville Drainage project.

Deterministic Analysis

The deterministic analysis applied the ABE model and used the most likely estimates for flood damages (yield loss), HWT yield loss and additional production costs associated with flooding. The ABE model was modified to include the additional production costs associated with flooding, as discussed earlier. For a description of the ABE model, refer to Lacewell and Freeman (1990).

Net benefits from the project are the increases in farmer net returns using normalized prices. Annual benefits to the Raymondville Drain area were estimated as the projected net returns after the project is in place less the estimated net returns under existing conditions.

Existing conditions are assumed before the current channel that was constructed by the locals. Benefits of the project are related to lowering the high water table and reduced flooding losses.

Study area-wide benefits were estimated for alternative scenarios. First, net benefits were estimated using normalized prices and a 48-inch or less water table as acres with a HWT. In addition, protection was assumed through (1) a 50 percent frequency flood, (2) a 20 percent frequency flood and (3) a 10 percent frequency flood. Thus, there are benefits due to the lowering of a HWT and added benefits of less flooding. The flooding benefits increase as the level of flood protection is increased to include more infrequent yet larger flood events.

Estimated flooding damages for existing conditions are based on low productivity levels in Group II soils. With the project, these soils increase in productivity, the water table is lower and hence damages less, which both contribute to providing a larger benefit to drainage.

Flooding benefits were calculated as the increase in expected net returns due to protection from a flood of a specified frequency. Total benefits were estimated by adding the benefits from lowering the water table and benefits from less flooding.

The project life was assumed to be 50 years. The model incorporates a five year period for Group II soils to linearly increase in productivity due to improved drainage. The annual benefits were discounted at 5.125% over a 50 year period. There was no consideration of land use shifting from agriculture production to urban development. Willacy County is not included in that part of South Texas that is experiencing rapid population growth.

Stochastic Analysis

Due to the random nature of floods and different stages of crop development, use of risk analysis was determined to be beneficial. The @RISK program was used in conjunction with the ABE model to generate distributions of benefits.

@RISK is essentially an "add-on", or macro, for spreadsheets; the ABE model is in Microsoft Excel format. @RISK works within the spreadsheet to allow distributions to be inserted in a cell, replacing the single value. This was done only for stochastically critical variables, such as percent yield loss due to flooding. Thus, the variable nature of crop yields due to factors other than flooding was consciously excluded. With this in mind, the Focus Groups were asked to estimate three levels of yield losses by crop, season, and flood damages. These values were incorporated into the model as triangular distributions, with low, most likely, and high possibilities. This range of yield losses was collected for each stage of crop development and for each flood size. Once entered into the ABE model, calculations were made using a Monte Carlo procedure. The details on high, mean and low values are presented in the 2001 report.

After the ABE model stochastically sets damage values for each crop and each flood frequency, the model then refers to the crop enterprise budget generator to calculate net returns, and proceeds through the remainder of the model. A stochastic simulation model should have a large number of iterations. This model was run for 1,000 iterations over a 50 year time span.

Over the 1,000 separate iterations, there is a wealth of information on range in expected benefits and the variability. This analysis saved the present value, average annual, and per acre value of benefits for flood protection of the 50% probability flood, the 20% probability flood, and the 10% probability flood

RESULTS

Agricultural benefits attributable to the Raymondville Drain are presented for the static (or deterministic) case, and then with risk analysis. The single value static estimate provides a benchmark.

Deterministic Results

The model was first applied using only the most likely estimates of yield losses due to flooding collected from the Focus Group meetings. Table 13 presents estimated annual project benefits composed of HWT benefits as well as 50%, 20% and 10% flood frequency protection. HWT annual benefits are estimated at $600 thousand. Flood protection benefits were estimated to be $190, $308, and $421 thousand for 50%, 20%, and 10% flood frequency protection, respectively. This suggests total annual agricultural benefits range from $726 thousand to $968 thousand.

Table 13. Summary of annual benefits to the project

Study Area	Raymondville Drain
HWT benefits	$600,907
Flood protection benefits	
50% frequency protection	$189,694
20% frequency protection	$308,123
10% frequency protection	$420,945
Price Series	Normalized
Water table of 48" or less below field surface	

Using the values of the static analysis, it is assumed there are temporal adjustments in agricultural land base. This means there are rising benefits over the first five years due to rehabilitation of Group II soils. The annual benefits are discounted at 5.125% and summed over 50 years to give the present value of benefits attributable to the project.

Table 14 summarizes the results for the static analysis. Protection from the two year flood (50% probability of occurrence) is $8.38 per acre, or $726 thousand per year on average. The present value of agricultural benefits attributable to the proposed Raymondville Drainage Project is estimated to be $13.0 million for protection of the 50% frequency flood, $15.3 million for the 20% frequency flood, and $17.3 million for the 10% frequency flood over the 50 year life of the project. The average annual per acre benefits range up to $11.18. These values are based on the static analysis using the best single estimates.

Table 14. Estimated present value of agricultural benefits for Raymondville Drain

Study Area: Raymondville Drain Interest Rate 0.05125						
	Flood Frequency Protection					
	50%		20%		10%	
Ave Annual Equiv Benefits	**BASE**	**AMOR**	**BASE**	**AMOR**	**BASE**	**AMOR**
High Water Table Benefits	**$6.94**	**$6.30**	**$6.94**	**$6.31**	**$6.94**	**$6.32**
Flood Protection Benefits	**$2.09**	**$2.09**	**$3.56**	**$3.56**	**$4.86**	**$4.89**
Total per acre benefits	**$8.38**	**$8.39**	**$10.50**	**$9.87**	**$11.80**	**$11.18**
Average annual benefits (1,000 $)		**726**		**854**		**968**
Total pv watershed benefits (mil $)	**13.0**		**15.3**		**17.3**	

Amortized benefits are over 50 years.
Type Prices Normalized.
Base value assumes constant acres over 50 years and full water table benefits from year 1 of the project.
Amortized values are average annual equivalent benefits assuming water table benefits increase for first five years of project and acres of agricultural land decline over the 50 year period.
Assumptions:

- Cropping pattern from Ag Statistics (1997-98)
- 4,600 acres converted from pasture to cropland
- Acres flooded by each flood sized from South Main Farmer Survey
- Extra costs associated with flooding included in estimates
- 40% floods with hurricane and 18.99% has high water table (Soil Survey)

Stochastic Results

Simulation models generate massive amounts of output. The challenge is to organize this output in a concise and understandable manner without omitting important information. Table 15 presents a summary of statistics for the 1,000 iterations of the ABE model for Willacy County. There are three sections that reflect the estimated benefits on a per acre basis, an annual basis for Willacy County and the present value of total benefits for the County. Three level of protection are included: two year event, five year event, and ten year even.

To review the average annual per acre benefit estimates, see the top section of Table 15. In this case, for the ten year level of protection the minimum benefit estimated across 1,000 iterations was $11.65. The average was $12.78 and the maximum was $13.90. The other values are interpreted in a similar manner. The average annual per acre benefits are about $1.30 higher going from the two year protection to the five year protection and from the five year to the ten year level of protection.

Average annual benefits are represented by the second part of the table. They range from $1.07 to $1.33 million for the two year level of protection, averaging $1.20 million. An approximate additional $250,000 is gained going to the five year level of protection and another $150,000 going to the ten year level of protection. Average annual benefits are $1.51 million for the ten year event level of protection.

The last part of Table 15 is the present value over 50 years of drainage for the three levels of protection. The average total benefits over the 1,000 iterations for the two-year event level of protection is an estimated $21.45 million, $24.19 million for five year and $27.00 million for ten year event protection.

Table 15. Stochastic analysis of benefits of the Raymondville Drain

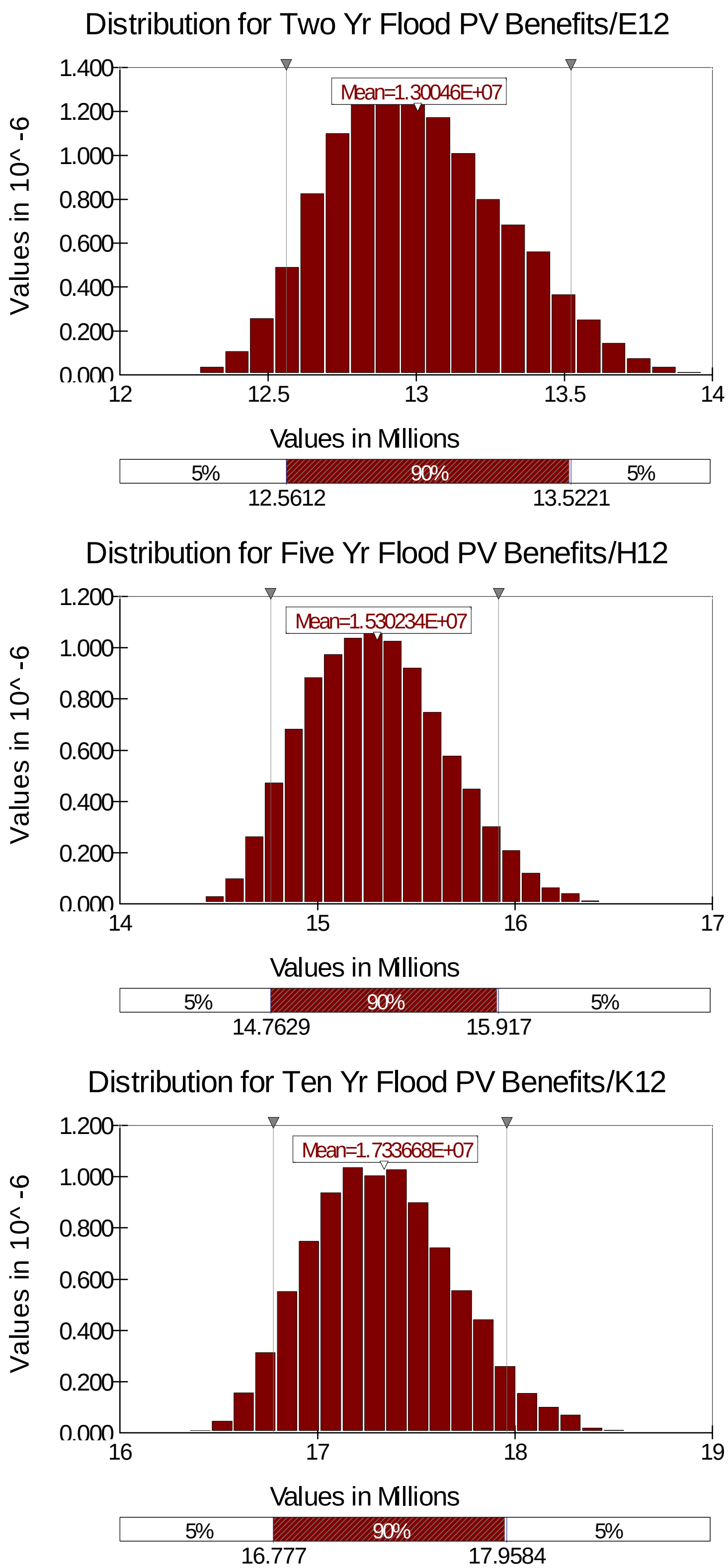
AVERAGE ANNUAL PER ACRE BENEFITS			
Protection	Two Year	Five Year (dollars)	Ten Year
Minimum	7.81	9.24	10.47
Mean	8.38	9.87	11.18
Maximum	9.00	10.66	12.04
AVERAGE ANNUAL BENEFITS			
Protection	Two Year	Five Year (thousand dollars)	Ten Year
Minimum	676	800	907
Mean	726	854	968
Maximum	780	923	1,042
TOTAL PRESENT VALUE OF BENEFITS			
Protection	Two Year	Five Year (million dollars)	Ten Year
Minimum	12.1	14.3	16.2
Mean	13.0	15.3	17.3
Maximum	14.0	16.5	18.7
5% Probability	12.6	14.8	16.8
95% Probability	13.5	15.9	

Based on 10,000 iterations of the ABE model.

Total Present Value of Benefits

Figure 2 shows the cumulative distribution function for present value of benefits over 50 years. The mean present values of benefits are $13.0 million, $15.3 million, and $17.3 million for the two-year, five-year and ten-year levels of protection, respectively. For the two year level of protection (top graph in Figure 2), there is a 90% probability that the present value of agriculture benefits over 50 years will be between $12.6 and $13.5 million. These values are $14.8 and $15.9 million for the five year level of protection and $16.8 million and $18.0 million for the ten year level of protection.

Figure 2. Distribution of Present Value of Benefits



CONCLUSIONS

The benefit estimates in this report were derived from two different types of simulations, static and stochastic. Both used the Agricultural Benefits Estimator (Lacewell and Freeman, 1990) spreadsheet model; however, the @RISK "add-on" was used in the stochastic model to more accurately reflect the risk and uncertainties of a project of this particular nature.

The static model uses only the "most likely" estimates of crop yield losses due to flooding as collected from the Focus Groups. It can therefore be considered a good point estimate of the present value of project benefits. In summary, the total present value of benefits from protection against a two year (50% probability), 5 year flood (20% probability), and 10 year (10% probability) flood are $13.0, $15.3, and $17.3 million, respectively.

The stochastic analysis, using the @RISK add-on, provides a range of benefits and the corresponding probabilities. Recognizing that flooding may occur under a variety of conditions, the data collected from the Focus Groups contained "low", "most likely" and "high" estimates of crop yield losses. All three values were used in the stochastic analysis, giving a range of possible outcomes. Urban benefits are not included in this analysis.

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Appendix Table 1. Soils, acres, yields and groupings for Raymondville Drain, Willacy County, Texas

		--------------dryland----------------			---irrigated---								
Soil	acres	Cotton	Sorghum	IB	Cotton	Sorghum	Carrots	Grpfruit	SC	IB	onions	oranges	Group
		lbs	cwt	aum	lbs	cwt	bag	box	ton	aum	bag	box	
Gab	1440.5			5									2
GmB	1980			6									2
Ja	2026.4			10									2
LaB	154.6			5									2
Mp	1261.7			4									2
Mu	481.5			6									2
SaB	861.8			3						10			2
SgB	0			5									2
Su	4036.6			4									2
Sz	1045.9			4									2
Tc	467.1			4									2
Total	**13756.10**			5.3									**2**
Po	**583.8**	**350**	**40**	**5**									**3**
Nu	2453	150		3	400					12			4
Rc	993.9	150	50	2	350					8			4
Re	44.8	150			350	50							4
Rs	125.2	150			350	50				8			4
Wf	7567.5	150	25	3	350	40				4			4
Total	**11184.4**	**150.0**	**27.9**	**3.2**	**361.0**	**40.2**				**6.2**			**4**
DeA	702.1	175	28	2	700	75		300		8		200	5
DfB	0	250	35	4	750	80		300		12		200	5
Rf	52.1	240	40	4	725	80	400			10	300		5
Rg	735.2	240	40	4	725	80		400		10	300		5
Total	**1489.4**	**209.4**	**34.3**	**3.1**	**713.2**	**77.6**	**400.0**	**351.2**		**9.1**	**300.0**	**299.0**	**5**
DfA	0	375	50	4	900	100		300		12		200	6
HaB	0	250	45	4	900	90	640	375	55	12		270	6
HgB	207.7	380	45		950	110		375	45	12	320	270	6

Appendix Table 1. Continued

		dryland			irrigated								
Soil	acres	Cotton lbs	Sorghum cwt	IB aum	Cotton lbs	Sorghum cwt	Carrots bag	Grpfruit box	SC ton	IB aum	onions bag	oranges box	Group
Ln	11321.2	375	50	5	900	100	480			12	335		6
Ly	13518.2	400	50	5	900	100	480			12	335		6
Rd	10014.6	375	60	5	900	105	520		45	12	350		6
Uf	14.3	150	50	5	1000	100		325	40	12	400	250	6
Us	0	150	50	5	1000	100		325	40	12	400	250	6
WaB	701	425	60		950	105	560	380	50		400	310	6
Total	**35777.0**	**385.4**	**53.0**	**5.0**	**901.3**	**101.6**	**492.8**	**378.0**	**45.3**	**12.0**	**340.4**	**300.1**	**6**
An	73.6	450	65	7	1200	120		375	50	12	450		7
Ca	744.5				1100	130	650			11	425		7
HaA	0	375	50	4	1100	115	640	375	55	12		270	7
HoA	5232.2	450	65		1200	130		375	45	12	450	270	7
Me	2393.5	400	50	4	1100	126	500			12	425		7
Ra	4194	500	65	6	1000	135		325		12		220	7
WaA	2335.9	500	70		1200	135	680	380	50		450	310	7
Yf	223.3	350	45	5	1100	110		375		12		300	7
Total	**15197.0**	**462.8**	**63.0**	**5.3**	**1122.7**	**131.2**	**597.2**	**358.6**	**46.6**	**11.9**	**442.7**	**260.9**	**7**
No Yield													
Ba	27.1												1
Dn	736.9												1
FaB	2966.9												1
Ic	1535												1
Le	1254.9												1
Lm	253.5												1
Ss	1385												1
Ta	6.3												1
W	305.9												1
Ws	147.4												1
Total	8618.9												**1**