

DR. LOBELL: BEFORE I START, I WANTED TO  
14 THANK THE ORGANIZERS FOR HAVING ME AND ESPECIALLY  
15 THANK CHRIS FOR GIVING YOUNG KIDS LIKE TED AND I A  
16 CHANCE TO PUT IN OUR TWO CENTS.

17 IF YOU'RE ANYTHING LIKE ME, BY THE TIME YOU  
18 GET TO THE THIRD TALK, YOUR MIND IS STARTING TO  
19 WANDER A LITTLE BIT, AND SO WHAT I WANTED TO DO IS  
20 NOT GET INTO TOO MUCH OF THE DETAILS. I JUST WANT TO  
21 MAKE A FEW KEY POINTS, WHAT I VIEW AS KEY POINTS IN  
22 CLIMATE CHANGE IN AGRICULTURE. AND I WANT TO MAKE  
23 THESE ON THREE TOPICS THAT ARE GOING ALONG WITH THE  
24 SESSION'S THEME, WHICH IS THE IMPACTS OF CLIMATE  
25 CHANGE ON AGRICULTURE, SOME OF THE FEEDBACKS THAT

0341

1 AGRICULTURE MAY PROVIDE TO CLIMATE, AND THEN SOME OF  
2 THE THINGS WE MIGHT DO IN TERMS OF ADAPTATION.

3 SO LET ME BEGIN WITH SOME BACKGROUND.  
4 GENERALLY, WHEN WE DISCUSS IMPACTS OF CLIMATE CHANGE  
5 ON AGRICULTURE, WE'RE TALKING ABOUT TWO COMPETING  
6 FACTORS: ONE IS THE GENERALLY POSITIVE EFFECT OF CO2  
7 ON CROPS, AND THE OTHER IS THE DIRECT EFFECT OF THE  
8 CLIMATE CHANGES ON THE CROPS.

9 I THINK IT IS IMPORTANT TO POINT OUT THAT  
10 ONE OF THE THINGS THAT THE MAUNA LOA RECORD REALLY  
11 MOTIVATED WAS A LOT OF STUDIES LOOKING AT THE EFFECTS  
12 OF CO2 ON CROPS. AND SO WE HAVE NOW HUNDREDS OF  
13 STUDIES, BOTH IN THE LABORATORY AND NOW IN THE FIELD  
14 INCREASINGLY, ABOUT HOW CROPS RESPOND TO CO2. AS I  
15 SAID BEFORE, THE EFFECTS ARE GENERALLY POSITIVE.

16 THIS IS A SUMMARY FIGURE FROM A RECENT  
17 STUDY IN "SCIENCE" WHERE, ON THE LEFT, IS SHOWN THE  
18 RESPONSE OF C3 CROPS, SO THESE ARE MOST OF THE CROPS  
19 GROWN IN THE WORLD; THAT'S WHEAT, RICE, AND OTHER  
20 MAJOR CROPS. AND ON THE RIGHT ARE THE C4 CROPS,  
21 WHICH ARE A HANDFUL OF CROPS BUT SOME VERY IMPORTANT  
22 ONES, LIKE MAIZE AND SUGARCANE. ABOUT A QUARTER OF  
23 THE CALORIES WE CONSUME IN THE WORLD ARE FROM C4  
24 CROPS.

25 AND THESE ARE TWO DIFFERENT PHOTOSYNTHETIC

0342

1 PATHWAYS. SO WHAT YOU SEE IS -- THERE YOU GO, IT  
2 WENT IN AND OUT. ANYHOW, WHAT WE SEE IS THAT THE C3  
3 CROPS ARE QUITE RESPONSIVE. YOU GET ROUGHLY A  
4 17-PERCENT INCREASE AT A LEVEL OF 550 PPM. AND C4  
5 CROPS ARE LESS SO. AS YOU CAN SEE, THESE ARE RESULTS  
6 TRYING TO EMPHASIZE THE DIFFERENCE BETWEEN THE NEW  
7 EXPERIMENTS IN THE FIELD, THE CO2 ORIGINAL  
8 EXPERIMENTS, AND THE PREVIOUS ONES THAT HAVE BEEN  
9 ENCLOSURE STUDIES. THERE'S BEEN QUITE A BIT OF  
10 CONTROVERSY ABOUT WHETHER THE FACE EXPERIMENTS REALLY  
11 ARE SHOWING A LOWER RESPONSE THAN WE THOUGHT. MY OWN  
12 VIEW IS THAT THE SAMPLE SIZES AREN'T REALLY LARGE  
13 ENOUGH TO SAY ANYTHING WITH GREAT CONFIDENCE.

14 SO WHAT I WILL BE TALKING ABOUT IS REALLY  
15 USING THE VALUES THAT ARE IN MOST CROPS AND MODELS,  
16 WHICH IS AS SHOWN HERE, THE 17 AND 6 PERCENT,  
17 RESPECTIVELY. SO TO HELP US THINK ABOUT THAT, WHAT I

18 HAVE DONE IS JUST TO PLOT OUT THE CO2 TRAJECTORIES FOR  
19 THREE EMISSION SCENARIOS THAT HAVE BEEN DISCUSSED  
20 ALREADY, A2, A1B, AND B1. THESE ARE NOT THE EXTREME  
21 RANGE ENTIRELY OF WHAT THE IPCC SCENARIO CONSIDERS,  
22 AND IT IS CERTAINLY NOT INCLUDING WHAT WE'VE SEEN  
23 RECENTLY AS PART OF THOSE TRAJECTORIES, BUT THIS IS  
24 AGAIN JUST TRYING TO GIVE YOU SOME PERSPECTIVE ON  
25 WHAT THIS CO2 RESPONSE MEANS.

0343

1 IF YOU MAP OUT THAT RESPONSE FUNCTION TO  
2 THE CO2 LEVELS, YOU CAN SEE THAT ON THE LEFT IT HAS  
3 C3; ON THE RIGHT IS C4. THE C3 CROPS FOR SAY AN A2  
4 SCENARIO ARE ENHANCED BY A FACTOR OF 30 PERCENT, SO  
5 1.3 RELATIVE TO A BASELINE YEAR 2000; C4 CROPS LESS  
6 SO; AND AS YOU GET LOWER LEVELS OF CO2, YOU'RE GOING  
7 TO HAVE LESS ENHANCEMENT. SO THERE IS A SUBSTANTIAL  
8 BENEFIT OF CO2 TO CROPS, AND THAT IS NOT SOMETHING  
9 THAT IS DEBATED. THE REAL QUESTION IS WHAT IS THE  
10 EXACT MAGNITUDE OF IT. BUT AS I SAID, THIS IS ONLY  
11 ONE FACTOR THAT IS GOING INTO THE IMPACTS.

12 AT THE GLOBAL SCALE, THE OTHER REAL FACTOR  
13 IS THE EFFECT OF TEMPERATURE, AND I DON'T WANT TO GET  
14 INTO THE DETAILS OF HOW WE UNDERSTAND THIS AND WHAT  
15 ARE THE DATA BEHIND IT. THE FACT IS YOU CAN FIND  
16 PLACES IN THE WORLD WHERE CROPS BENEFIT FROM WARMING;  
17 BUT BY AND LARGE, MOST PLACES AND MOST CROPS TEND TO  
18 RESPOND NEGATIVELY TO TEMPERATURE. AS A GENERAL RULE  
19 OF THUMB, GLOBALLY, I WOULD SAY THAT C3 CROPS TEND TO  
20 LOSE ABOUT 6 PERCENT OF THEIR YIELD PER DEGREE  
21 CELSIUS, AND C4 CROPS ARE SLIGHTLY MORE SENSITIVE,  
22 LARGELY BECAUSE THEY'RE GROWN MORE IN THE TROPICS,  
23 WHERE IT ALREADY IS QUITE WARM.

24 IF WE MAP OUT THE TEMPERATURE TRAJECTORIES  
25 CORRESPONDING TO THE CO2 TRAJECTORIES AND APPLY THESE

0344

1 FUNCTIONS, WHAT YOU SEE IS TEMPERATURE HAS A PRETTY  
2 STRONG DOWNWARD PRESSURE ON BOTH THE C3 AND C4 CROPS  
3 THROUGHOUT THE NEXT CENTURY. IF YOU THEN COMBINE  
4 THESE WITH THE CO2 EFFECTS I SHOWED PREVIOUSLY, YOU  
5 GET A GENERAL SENSE THAT C3 CROPS TEND TO CANCEL C4  
6 CROPS. THE TEMPERATURE EFFECTS TEND TO DOMINATE.

7 SO I HAVE SIMPLIFIED THIS QUITE A BIT; BUT  
8 IF YOU REALLY LOOK AT WHAT MOST OF THE MAJOR GLOBAL  
9 ASSESSMENTS ARE DOING, THIS IS THE REAL MAIN  
10 EQUATIONS THAT ARE IN IT AND REALLY EXPLAINING WHAT  
11 YOU GET OUT OF IT. THERE IS QUITE A BIT OF  
12 UNCERTAINTY AROUND THIS, WHICH IS IMPORTANT TO  
13 RECOGNIZE, I THINK.

14 THIS IS JUST AN IPCC FIGURE SHOWING YOU  
15 SOME DIFFERENT STUDIES THAT HAVE LOOKED AT THE  
16 TRAJECTORY OF FOOD PRICES, WHICH YOU CAN USE AS A  
17 PROXY OF GLOBAL PRODUCTION. AS PRODUCTION DIPS,  
18 PRICES GO UP. SOME STUDIES, LIKE I SAID, OUT TO  
19 550 PPM, WHICH WOULD BE MAYBE IN THIS TEMPERATURE  
20 RANGE HERE, ARE FAIRLY INSENSITIVE TO CLIMATE CHANGE.  
21 SOME SHOW A SLIGHT INCREASE IN PRICE; SOME A  
22 DECREASE. ONE COMMON THING WITH ALL THESE MODELS IS

23 THE WARMER YOU GET, YOU TEND TO SEE PRETTY  
24 SIGNIFICANT PRICE INCREASES. SO THAT THE CO2 EFFECT I  
25 SHOWED YOU IN THE BEGINNING LEVELED OFF WHERE THE

0345

1 TEMPERATURE EFFECT DOESN'T. SO AS YOU GET MORE AND  
2 MORE WARMING, THE TEMPERATURE EFFECT INCREASINGLY  
3 DOMINATES.

4 NOW, THERE ARE TWO POINTS I WANTED TO MAKE  
5 ON THIS -- WELL, ACTUALLY THREE POINTS, I GUESS: ONE  
6 IS THAT THIS AGAIN -- ALL THESE STUDIES HERE AND WHAT  
7 I HAVE SHOWN ARE CONSIDERING PRETTY AVERAGE CLIMATE  
8 SENSITIVITY. SO WE'RE NOT CONSIDERING WHAT WAS  
9 MENTIONED YESTERDAY ABOUT POTENTIALLY 25-DEGREE  
10 FARENHEIT WARMING OVER LAND. THOSE TYPES OF THINGS  
11 WOULD OBVIOUSLY THROW THESE PRICE CHANGES UP QUITE A  
12 BIT, AND SO IT'S IMPORTANT TO RECOGNIZE THE TAILS OF  
13 THE DISTRIBUTION.

14 THE OTHER THING THAT I THINK IS IMPORTANT  
15 TO RECOGNIZE IS THAT THESE MODELING ASSESSMENTS THAT  
16 HAVE CONSIDERED THESE TWO FACTORS, AND A FEW OTHERS,  
17 REALLY ARE ONLY CAPTURING A PIECE OF WHAT WE REALLY  
18 KNOW AFFECTS CROPS, AND IT IS REALLY JUST REFLECTING  
19 OUR IGNORANCE IN TERMS OF UNDERSTANDING HOW THESE  
20 OTHER THINGS AFFECT CROPS; OR IN THE CASE OF  
21 RAINFALL, HOW CLIMATE MODELS ARE ABLE TO SIMULATE  
22 RAINFALL.

23 IT IS IMPORTANT TO RECOGNIZE WHAT'S NOT IN  
24 THE MODELS AND WHAT THAT MEANS. SO I'VE LISTED HERE  
25 A FEW. I WOULD PUT IN ALSO SEA LEVEL, WHICH PAUL

0346

1 JUST TALKED ABOUT, WHICH IS RELATED TO FLOODING,  
2 OBVIOUSLY.

3 BUT, FOR EXAMPLE, EXTREME HEAT EVENTS,  
4 THERE HAS BEEN SOME NICE WORK RECENTLY SHOWING EVEN  
5 FOR SHORT PERIODS OF TIME IF CROPS ARE EXPOSED TO  
6 REALLY EXTREME HEATS, THERE IS A VERY NONLINEAR  
7 RESPONSE, AND THIS IS NOT REALLY CAPTURED IN ANY OF  
8 THE ASSESSMENTS.

9 PESTS AND WEEDS WE REALLY DON'T UNDERSTAND  
10 WELL ENOUGH, SO WE HAVE LEFT THEM OUT OF ALL THE  
11 MAJOR MODELS THAT ARE BEING USED RIGHT NOW; AND SO  
12 IT'S POSSIBLE THAT THAT COULD CHANGE SIGNIFICANTLY  
13 WITH CLIMATE.

14 AND ANOTHER ONE THAT I'VE SHOWN HERE, THAT  
15 IS A QUOTE FROM THE IPCC THAT'S TALKING ABOUT HOW THE  
16 HIMALAYAN GLACIERS ARE RECEDING QUITE FAST. AND  
17 AGAIN, WATER SUPPLY IS NOT SOMETHING -- IT IS  
18 SOMETHING THAT HAS BEEN STUDIED IN CERTAIN CASE  
19 STUDIES; BUT IN TERMS OF THE GLOBAL PICTURE, IT HAS  
20 NOT REALLY BEEN CAPTURED. AND IF, FOR EXAMPLE, THE  
21 INDO-GANGETIC PLAINS START TO HAVE A SERIOUS CONSTRAINT  
22 ON WATER RESOURCES BEYOND WHAT IT ALREADY HAS, YOU'LL  
23 SEE SOME VERY SERIOUS IMPACTS THAT ARE NOT REALLY  
24 PROJECTED BY THE CURRENT SUITE OF MODELS.

25 ANOTHER IMPORTANT POINT THAT I WANTED TO

0347

1 MAKE -- IT WAS ALSO TOUCHED ON YESTERDAY -- IS YOU'VE

2 GOT GLOBAL AVERAGES ARE CERTAINLY MASKING A LOT AT  
3 THE REGIONAL SCALE. WHAT I WANTED TO SHOW HERE WAS A  
4 STUDY WE DID RECENTLY WHERE WE SPLIT UP THE  
5 DEVELOPING WORLD INTO DIFFERENT REGIONS, AND WE TRIED  
6 TO LOOK AT WHAT COULD WE SAY ABOUT THE MAJOR CROPS  
7 THAT ARE GROWING IN EACH REGION, BOTH KNOWING WHAT WE  
8 KNOW ABOUT HOW CLIMATE WILL CHANGE OR WHAT WE DON'T  
9 KNOW ABOUT HOW CLIMATE WILL CHANGE AND KNOWING WHAT  
10 WE KNOW OR WHAT WE DON'T KNOW ABOUT HOW CROPS RESPOND  
11 TO THAT CHANGE. SO WE'RE LOOKING HERE AT MULTIPLE  
12 CLIMATE MODELS AND WE'RE LOOKING AT MULTIPLE CROP  
13 MODELS THAT ARE BASED ON DIFFERENT SUBSAMPLES OF THE  
14 HISTORICAL DATA. SO THESE ARE ALL STATISTICAL TYPE  
15 OF CROP MODELS, BUT THEY GIVE SIMILAR RESULTS TO  
16 OTHER MORE PROCESS-BASED APPROACHES.

17 SO WHAT YOU SEE HERE IS A DISTRIBUTION  
18 COMPUTED FROM THESE GROUPS OF MODELS WHERE IT IS  
19 SHOWING YOU KIND OF THE MEDIAN EXPECTED IMPACT, ALONG  
20 WITH THE 25TH AND 75TH PERCENTILE, AND THIS LINE HERE  
21 IS GIVING YOU BASICALLY THE LOW AND THE HIGH VALUES  
22 OUT OF THESE MODELS. SO WHAT WE WOULD EXPECT FOR THE  
23 PRODUCTION CHANGE, AND THIS IS A RATHER SHORT TIME  
24 SCALE OUT TO 2030, AND THE IDEA HERE WAS TO REALLY  
25 FOCUS ON THE TIME SCALE THAT MATTERS FOR INVESTMENTS

0348

1 TO AGRICULTURE, WHERE DO WE REALLY NEED TO PRIORITIZE  
2 ADAPTATION INVESTMENTS. AS I'LL TALK A LITTLE BIT  
3 MORE ABOUT IN A SECOND, ADAPTATION IS QUITE  
4 IMPORTANT, BUT WE'RE NOT GOING TO BE ABLE TO DO IT  
5 EVERYWHERE ALL AT ONCE. AND SO THE IDEA WAS TO SEE  
6 WHERE THE IMPACTS ARE WORST. AND WHAT YOU SEE IS  
7 THAT THERE ARE SOME CASES WHERE WE HAVE NO DOUBT THAT  
8 THINGS ARE GOING TO GET QUITE BAD. I'LL POINT OUT  
9 HERE THAT MAIZE IN SOUTH AFRICA, WHICH IS THE MOST  
10 IMPORTANT CROP IN THIS REGION, LOTS OF POOR PEOPLE IN  
11 THIS REGION, WE'RE PROJECTING A MEDIAN PROJECTION OF  
12 ABOUT 30 PERCENT LOSS IN PRODUCTION OUT TO 2030.  
13 THIS IS A PART OF THE WORLD WHERE MAIZE IS ALREADY  
14 GROWN AT THE LIMITS OF WHAT IT LIKES IN TERMS OF  
15 TEMPERATURE, WHERE CLIMATE MODELS ARE PRETTY  
16 UNANIMOUS THAT IT IS GOING TO GET QUITE WARM AND  
17 QUITE DRY. SO THIS IS A CASE WHERE EVEN THOUGH THE  
18 GLOBAL PICTURE AFTER 2030 MAY BE FAIRLY BENIGN IN  
19 THESE MODELS, WE CAN CERTAINLY NOT SAY THAT'S THE  
20 CASE FOR A PLACE LIKE SOUTH AFRICA OR THE SOUTHERN  
21 AFRICA REGION.

22 YOU CAN ALSO NOTICE IN SOUTH ASIA, ANOTHER  
23 VERY IMPORTANT PLACE IN TERMS OF WHAT WAS TALKED  
24 ABOUT YESTERDAY BY VICE ADMIRAL GAFFNEY IN TERMS OF  
25 THE VULNERABLE OR POTENTIAL VOLATILE REGIONS, WE ALSO

0349

1 EXPECT THAT THE MAJOR CROPS IN THIS REGION, RICE AND  
2 WHEAT IN PARTICULAR, WILL BE DECREASING. SO THE  
3 TAKE-HOME POINT HERE IS THAT PARTICULARLY SOUTHERN  
4 AFRICA AND SOUTH ASIA IS GOING TO BE HIT QUITE BAD IN  
5 THE NEAR TERM REGARDLESS OF WHAT WE DO ON THE  
6 MITIGATION SIDE OF THINGS.

7                   BEFORE GETTING TO ADAPTATION, I WANT TO  
8 MAKE A FEW POINTS ABOUT FEEDBACK. CHRIS ASKED ME TO  
9 SAY A FEW THINGS. I THINK THERE ARE TWO POINTS I  
10 WANTED TO MAKE: ONE IS THAT AS CROP YIELDS  
11 POTENTIALLY GO DOWN WITH CLIMATE CHANGE, ONE WAY  
12 PEOPLE RESPOND IS BY EXPANDING MORE AREA FOR FOOD.  
13 SO WE KNOW, WE HAVE AN INCREASING UNDERSTANDING OF  
14 WHAT THAT MEANS IN TERMS OF FEEDBACK TO CLIMATE.  
15 THIS IS A SIMULATION THAT WAS RUN AT LIVERMORE, WHERE  
16 WE JUST WIPED OUT FORESTS IN THE TROPICAL REGION AND  
17 LOOKED AT WHAT HAPPENED TO GLOBAL TEMPERATURES. AND  
18 YOU CAN SEE THAT ON THE NET IT IS A DRAMATIC WARMING  
19 EFFECT ON GLOBAL TEMPERATURES. AND THERE ARE A FEW  
20 REASONS FOR THIS: THE RELEASE OF THE CARBON THAT IS  
21 CURRENTLY IN THE TREES AND THE SOILS IN THAT REGION.  
22 THERE ARE ALBEDO CHANGES AND THINGS. ANOTHER KEY  
23 PROCESS IS THAT YOU'RE NOW LOSING A POTENTIAL SINK  
24 FOR THE FUTURE. WE HAVE TALKED ABOUT THE AIRBORNE  
25 FRACTION QUITE A BIT YESTERDAY, BY PIETER AND OTHERS.

0350

1 AND THEN GOING TO THE FUTURE, MODELS PREDICT QUITE A  
2 BIG SINK, MOST MODELS PREDICT QUITE A BIT OF SINK  
3 THROUGHOUT THE TROPICS, AND SO YOU'RE LOSING THAT AS  
4 YOU CONVERT THAT TO AGRICULTURE. I SHOULD POINT OUT  
5 THAT A LOT OF THESE CONVERSIONS WILL TAKE PLACE  
6 REGARDLESS OF CLIMATE CHANGES AS PEOPLE TRY TO FEED A  
7 GROWING POPULATION, BUT CERTAINLY THE POTENTIAL FOR  
8 CLEARING IS GREATLY EXACERBATED BY POTENTIAL IMPACTS  
9 FROM CLIMATE CHANGE.

10                   ANOTHER POINT I WANTED TO MAKE WAS THE  
11 ISSUE OF BIOFUEL, WHICH YOU CAN VIEW AS A RESPONSE TO  
12 CLIMATE CHANGE IN SOME SENSE OF THE AGRICULTURAL  
13 COMMUNITY. JUST A FEW NUMBERS TO THROW IN HERE IS  
14 THAT AS OF LAST YEAR, ABOUT 14 PERCENT OF THE CORN  
15 CROP IN THE U.S. WENT TO ETHANOL. THE USDA EXPECTS  
16 THAT NUMBER TO REACH 30 PERCENT. "THE WALL STREET  
17 JOURNAL" HAD A COVER STORY ABOUT HOW THE ETHANOL  
18 BUSINESS IS CRASHING A LITTLE BIT, SO MAYBE THAT  
19 NUMBER WON'T TURN OUT TO BE TRUE. BUT I THINK THAT  
20 IT IS CERTAINLY TRUE THAT THERE IS A COMPETITION AT  
21 SOME LEVEL BETWEEN USING CROPS FOR BIOFUEL AND USING  
22 THEM FOR FOOD. AND SO A GOOD RULE OF THUMB THAT I  
23 HAVE HEARD IS ONE TANK OF AN SUV IN TERMS OF CORN  
24 ETHANOL IS EQUIVALENT TO ENOUGH FOOD TO FEED SOMEBODY  
25 FOR A YEAR.

0351

1                   NOW, A LOT OF PEOPLE TALK ABOUT CELLULOSIC  
2 ETHANOL AS A SECOND GENERATION THAT WE REALLY NEED TO  
3 GET TO AVOID THIS FOOD-FOR-FUEL COMPETITION. SOME  
4 WORK THAT CHRIS HAS BEEN LEADING LATELY, AND I HAVE  
5 BEEN INVOLVED WITH, IS TRYING TO ESTIMATE HOW MUCH  
6 THAT REALLY COULD GET US. IT'S NOT A WHOLE LOT. SO  
7 I THINK THE POINT HERE IS THAT IF WE REALLY GET BIG  
8 TIME INTO BIOFUELS AS A MITIGATION STRATEGY, IT COULD  
9 HAVE LARGE FEEDBACKS TO CLIMATE THROUGH THE  
10 MECHANISMS THAT I TALKED ABOUT PREVIOUSLY, WHICH IS  
11 THAT FOOD PRICES LEAD TO LAND CHANGE, LEAD TO MORE

12 CLIMATE CHANGE. AND CERTAINLY, THE FOOD PRICE EFFECT  
13 DIRECTLY WOULD BE LARGE EVEN RELATIVE TO THE EFFECTS  
14 OF CLIMATE CHANGE ITSELF.

15 NOW, I THINK IT'S CERTAINLY TRUE THAT  
16 PEOPLE WILL ADAPT. I THINK, IN GENERAL, FARMERS AND  
17 GOVERNMENTS ARE NOT STUPID, AND THEY'RE TRYING TO  
18 MAKE A LIVING; AND WE GENERALLY THINK ABOUT TWO TYPES  
19 OF ADAPTATIONS:

20 ONE WE CALL AUTONOMOUS ADAPTATIONS, WHICH  
21 ARE THINGS THAT FARMERS WILL DO IN THEIR OWN INTEREST  
22 WITHOUT ANY INTERVENTION FROM SOME HIGHER AUTHORITY,  
23 AND THOSE ARE LISTED HERE, THINGS LIKE ADJUSTING  
24 PLANTING DATES, USING DIFFERENT VARIETIES THAN  
25 CURRENTLY EXIST. THERE ARE QUITE A FEW STRATEGIES.

0352

1 THERE IS ALSO THE MORE SUBSTANTIAL CHANGES  
2 THAT FARMERS CAN'T DO ON THEIR OWN, WHICH IS THE  
3 LONGER-TERM ISSUES OF DEVELOPING NEW VARIETIES OR  
4 LARGE-SCALE ISSUES OF DEVELOPING INFRASTRUCTURE LIKE  
5 IRRIGATION.

6 AS I SAID, IT IS REALLY NOT ARGUED  
7 ADAPTATION WILL OCCUR. IT'S A QUESTION LIKE WITH THE  
8 CO2 CASE OF WHAT WILL BE THE MAGNITUDE. THE IPCC, IN  
9 GENERAL, RELIES ON MODELS THAT HAVE CONSIDERED  
10 ADAPTATION. THERE'S ARGUMENT ABOUT WHETHER IT IS  
11 ENOUGH ADAPTATION OR TOO MUCH ADAPTATION; BUT IT IS  
12 IMPORTANT, I THINK, TO RECOGNIZE THAT WHEN PEOPLE  
13 LOOK AT PROJECTIONS FROM THE IPCC OR STUDIES THAT ARE  
14 SUMMARIZED IN THE IPCC, THAT THEY ALREADY ARE  
15 CONSIDERING QUITE A BIT OF ADAPTATION WILL OCCUR.  
16 THEY'RE ALSO NOT CONSIDERING THE COST OR THE SUCCESS  
17 RATES, BUT THEY ARE IN THOSE PROJECTIONS, AND I THINK  
18 THAT IS IMPORTANT TO POINT OUT.

19 ANOTHER THING I WANTED TO POINT OUT IS THAT  
20 WHILE, IN THEORY, ADAPTATION WILL HAPPEN, IT'S NOT AN  
21 EASY THING TO DO IN PRACTICE. THERE'S DIFFICULTY OF  
22 RECOGNIZING FROM A FARMER PERSPECTIVE OR EVEN AT A  
23 REGIONAL SCALE WHAT IS HAPPENING TO CLIMATE, IS IT  
24 REALLY CHANGING. THERE'S ISSUES OF THE UP-FRONT  
25 EXPENSES.

0353

1 AND THEN I THINK THE POINT I REALLY WANTED  
2 TO EMPHASIZE IS THAT THERE'S A LOT OF LAG IN THE  
3 SYSTEM, JUST LIKE WE TALKED ABOUT LAG IN THE CLIMATE  
4 SYSTEM, LAG IN THE ENERGY SYSTEM. THERE IS A LOT OF  
5 LAG IN THE AGRICULTURE DEVELOPMENT SYSTEM. AND  
6 THERE'S BEEN A LOT OF WORK ON THIS IN THE LITERATURE  
7 ON AGRICULTURAL POLICY AND RESEARCH.

8 THIS FIGURE, WHICH IS NOT VERY CLEAR, BUT  
9 IT IS SHOWING AN ANALYSIS OF HUNDREDS OF STUDIES  
10 LOOKING AT THE RETURN ON INVESTMENTS IN AGRICULTURAL  
11 RESEARCH. AND YOU CAN SEE THAT OUT TO 10 YEARS IT IS  
12 REALLY JUST A SINK FOR MONEY, YOU DON'T GET MUCH OUT  
13 OF IT, AND THE BENEFITS WHICH ARE SHOWN IN RED HERE  
14 REALLY PEAK AROUND YEAR 20. AND SO AS WE START TO  
15 THINK ABOUT ADAPTATION TO 2030, WHICH WERE THE  
16 PROJECTIONS THAT I SHOWED YOU PREVIOUSLY, WE'RE

17 TALKING ABOUT POSSIBLY 20 YEARS UNTIL WE REALLY ARE  
18 ABLE TO IMPLEMENT STRATEGIES OR VARIETIES OR WHATEVER  
19 WE'RE WORKING ON IN TERMS OF ADAPTATION RIGHT NOW.  
20 AND SO THERE IS REALLY NOT MUCH TIME TO WASTE. AND  
21 AGAIN, THE URGENCY AND THE SCALE OF THE ADAPTATION  
22 PROBLEM IS SUCH THAT I THINK IT'S CERTAINLY  
23 COMPARABLE TO THE MITIGATION PROBLEM AND NEEDS TO BE  
24 REALLY THOUGHT ABOUT MORE SERIOUSLY.

25 TO GIVE A PERSPECTIVE ON HOW SERIOUSLY IT  
0354

1 IS TAKEN, IN MY VIEW, IS THE CG CENTER, THE  
2 CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL  
3 RESEARCH, WHICH IS REALLY RESPONSIBLE FOR MUCH OF THE  
4 RESEARCH THAT GOES ON IN THE DEVELOPING WORLD, HAS A  
5 BUDGET THAT IS APPROXIMATELY \$400 MILLION. SO IT IS  
6 REALLY SMALL CHANGE. SOMEBODY TALKED ABOUT YESTERDAY  
7 \$50 MILLION BEING SMALL CHANGE FOR A U.S. PROGRAM ON  
8 MITIGATION POLICY. SO IT IS REALLY, I THINK,  
9 SOMETHING THAT HAS NOT BEEN SERIOUSLY ADDRESSED  
10 ENOUGH, IN MY OPINION.

11 SO TO SUMMARIZE THE POINTS I WANTED TO MAKE  
12 IS THAT YOU'LL CERTAINLY HEAR A LOT ABOUT CO2  
13 BENEFITS, AND THOSE ARE TRUE, BUT THE QUESTION IS HOW  
14 DO THOSE COUNTER THE NEGATIVE EFFECTS OF CLIMATE  
15 CHANGES; THAT WE DON'T NECESSARILY HAVE ALL OF THE  
16 NEGATIVE EFFECTS IN OUR MODELS, AND SO WHEN WE THINK  
17 ABOUT UNCERTAINTIES, WE'RE PROBABLY THINKING MORE  
18 ABOUT DOWN-SIDE UNCERTAINTIES AS OPPOSED TO UP-SIDE  
19 UNCERTAINTIES, BECAUSE A LOT OF THOSE THINGS I  
20 MENTIONED, LIKE FLOODING, PESTS AND DAMAGES, EXTREME  
21 HEATS, THOSE ARE VERY UNLIKELY TO IMPROVE OUR  
22 PROJECTIONS; THEY'RE MORE LIKELY TO REDUCE THEM. SO  
23 WE REALLY DON'T HAVE A GREAT HANDLE ON OUR  
24 UNCERTAINTIES, BUT CERTAINLY IT LOOKS LIKE THOSE  
25 UNCERTAINTIES WILL BE PUSHED MORE INTO THE NEGATIVE

0355  
1 THAN THE POSITIVE.

2 AT THE GLOBAL SCALE, YOU SEE POTENTIALLY  
3 BENIGN EFFECTS, BUT CERTAINLY NOT AT THE REGIONAL  
4 SCALE. I THINK THAT WE REALLY NEED TO BE WORKING ON  
5 ADAPTATION NOW. THERE ARE POTENTIAL FEEDBACKS FROM  
6 AGRICULTURE, BUT THEY'RE NOT GOING TO COMPARE TO THE  
7 TYPES OF FEEDBACKS THAT TED WILL TALK ABOUT.

8 I WOULD SAY THAT IF I HAD TO PICK THE  
9 SINGLE BIGGEST UNCERTAINTY IS WHAT WE'RE GOING TO DO  
10 TO ADAPT. IT'S NOT CLEAR THAT WE HAVE THE WILL TO  
11 REALLY CHANGE THESE SYSTEMS GIVEN THE TIME LAGS THAT  
12 ARE INVOLVED.

13 AND WITH THAT, I WILL STOP AND PASS IT  
14 ALONG TO TED.

15