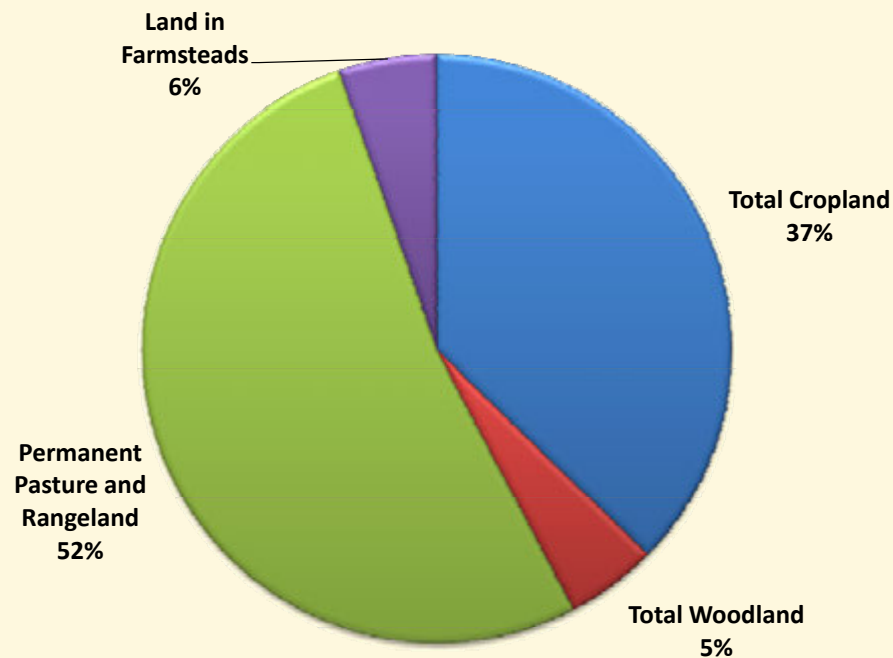


OUTLINE

- **Agriculture under AB 32**
 - **Rules and voluntary measures**
 - **Offsets**
 - **Suggested practices**
- **GHG emissions and costs of alternative crop practices**
- **Broad economic issues about agricultural impacts**
- **Conclusions**

LAND IN FARMS IN CALIFORNIA



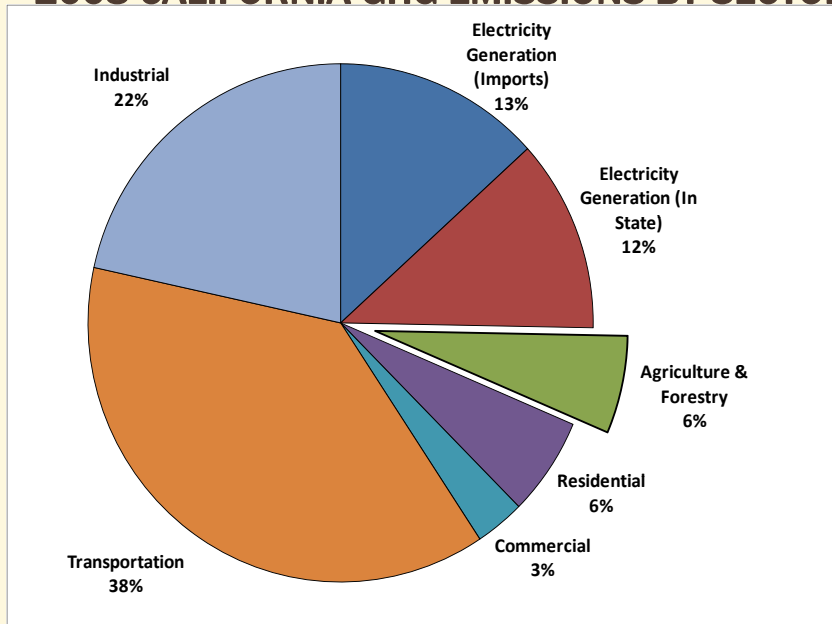
Source: USDA NASS, 2007 Census of Agriculture

FOCUS OF THE PRESENTATION: ADAPTATION OF AGRICULTURE TO CLIMATE CHANGE *POLICY*

- This presentation does not deal with the effects of agriculture on climate change nor the effects of climate change on agriculture
- Instead, it focuses on the effects of climate change *policy* on California agriculture and agriculture's adaptation to policy

AGRICULTURE IS A SIGNIFICANT CONTRIBUTOR TO CALIFORNIA GHG EMISSIONS

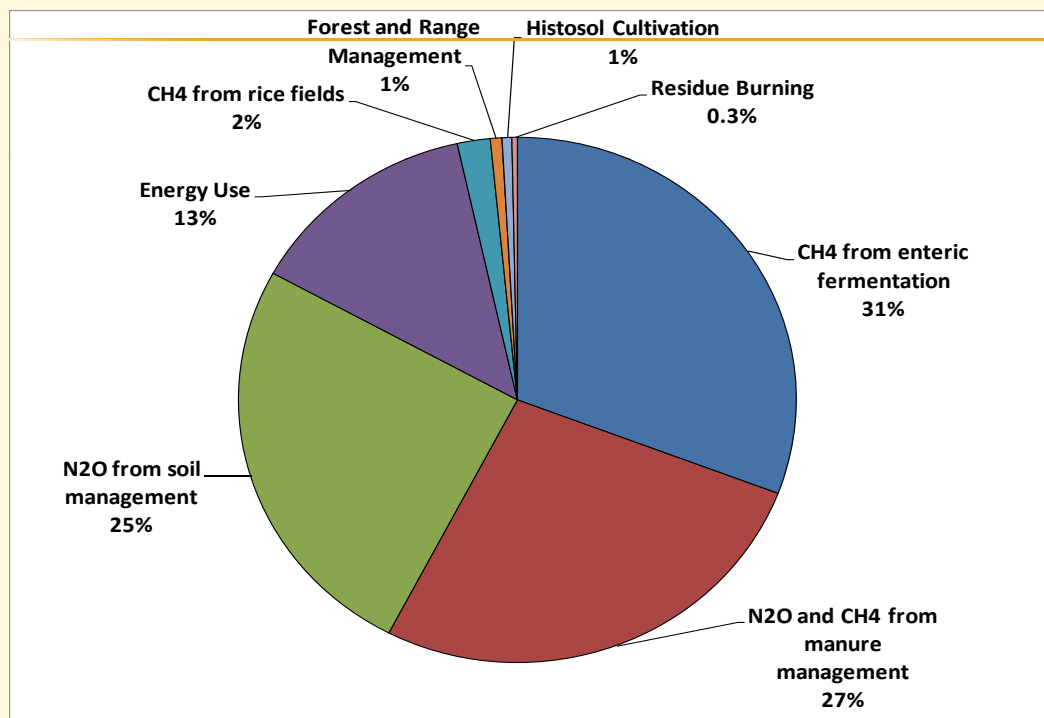
2008 CALIFORNIA GHG EMISSIONS BY SECTOR



By these measures Agriculture is about 1% of California GDP and 6% of California GHG emissions

Total 2008 net emissions = 473.76 million tCO₂eq.
Source: ARB. 2010. Greenhouse Gas Inventory Data

CALIFORNIA GHG EMISSIONS FROM AGRICULTURE



Total 2008 emissions from Agriculture and Forestry = 28.25 million tCO₂eq.
Source: ARB. 2010. Greenhouse Gas Inventory Data

AGRICULTURE UNDER AB 32

- **Agricultural emissions are not scheduled to be capped under AB 32**
 - **Policymakers decided that measurement and tracking was too difficult in agriculture**
 - **California Air Resources Board (ARB) assumed an emissions reduction of 1-3% by 2020 under Scoping Plan compared to business-as-usual (from about 29.8 to about 29-29.5 million tCO₂eq)**
 - **ARB further assumed 15% agricultural emissions reduction between 2020 and 2030**
 - **However, these reductions from agriculture are not included in ARB's overall GHG reductions**



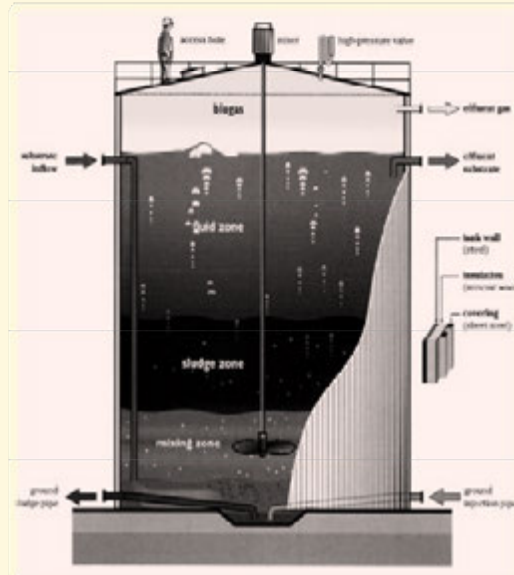
TOP 5 CALIFORNIA FARM COMMODITIES, by value

- 1 – Dairy Products**
- 2 – Greenhouse/Nursery**
- 3 – Grapes**
- 4 – Lettuce**
- 5 – Almonds**

Source: USDA

ONE SIGNIFICANT VOLUNTARY MEASURE

- Methane capture in digesters at dairies
 - Expected implementation: 2017-2020
 - Reduces emissions from dairy cattle by about 7.7% from 2008 emissions
- No mandatory policies under the current Scoping Plan



DIGESTERS ATTRIBUTABLE TO AB 32?

- Methane digesters have been around for decades
- No incentives/regulations directly in AB 32 or current plan
 - Will they be subsidized?
 - Some would be constructed anyway?
- ARB considers digesters to be a driving force behind GHG reductions in agriculture

SMALL INDIRECT UNDERTAKINGS

- **Anaerobic Digestion (some agricultural waste enters landfills)**
- **ARB research program for reduction strategies for nitrogenous fertilizers**
- **Tire pressure maintenance**
 - **Reduces fuel use, raises productivity**
 - **Reduces soil compaction, lowering N₂O emissions**
- **Perhaps future financial incentives for other GHG reducing practices**

FARMING IS ALSO AFFECTED BY MEASURES ON PROCESSING OF AGRICULTURAL OUTPUTS AND MANUFACTURING OF AGRICULTURAL INPUTS

- **Emissions from most food processing plants (tomato processing, wine, dairy butter/powder plants) will be capped under AB 32**
- **Input costs (eg. feed and fertilizer) will be affected by energy costs**

IMPACTS ON FARMING FOLLOW FROM EMISSIONS CAPS ON ENERGY PRODUCTION

- **Energy is a significant input to farm production, farm raw material processing and agricultural input production.**
 - **Examples of shares of energy costs in producers' total operating costs**
 - **Rice ~ 9.2% or 16.7% including fertilizer**
 - **Wine grapes ~ 6% or 9.3% including fertilizer**

IMPACTS ON FARMING FOLLOW FROM GHG EMISSIONS CAPS ON ENERGY PRODUCTION AND HIGHER ENERGY COSTS

- **Food processing among most energy intensive industries in California**
 - **Only transport and agro-chemicals are higher**
 - **Milk is among most energy intensive within food processing**
- **When other, complementary, input costs rise in processing and marketing, the price offered to farm producers for raw materials will fall**
- **Impact may encourage shifts out of state where feasible, especially for livestock industries**

EFFECTS OF HIGHER COSTS OFF THE FARM ON FARM INDUSTRIES

- **For crop industries that are land dependent, shifting out of California is not likely**
 - **So, the result of higher processing and marketing costs is lower land values**
- **For other crops where California's market share is high we expect some higher prices to buyers,**
 - **So, food prices rise, especially for fruits and vegetables**
- **Intensive livestock industries such as dairy or poultry are more mobile,**
 - **Therefore, some shifts out of state are likely**

ALLOWANCES VERSUS OFFSETS

- **Allowances**
 - **Facilities under the cap can trade "allowances"**
 - **Firms can abate emissions and sell their "allowances" or buy "allowances" from others and not abate**
- **Offsets**
 - **GHG reductions that occur outside of the cap**
 - **Sectors not under the cap can sell "offsets" to firms under the cap to meet their emissions reduction**

AB 32 SCOPING PLAN ALLOWS FOR SALE OF OFFSETS BY AGRICULTURE

- Farming will be outside of regulated cap but can trade offsets
- No farm offsets are currently certified
- ARB's examples of offsets currently acknowledged as potentially valuable:
 - Methane digesters on dairy operations
 - Cover crops or tillage practices used to build up soil carbon (organic matter)
 - Biofuels

AB 32 REQUIRES THAT OFFSETS MUST BE:

- **Additional**
 - Only reductions that would not have otherwise occurred can be counted. "Leakage" must be avoided.
- **Permanent**
 - Reductions should not be reversible.
- **Quantifiable**
 - Reductions must be demonstrable against a known baseline and follow standard protocols.
- **Verifiable**
 - A transparent verification process must be developed.
- **Enforceable**
 - Projects must be accessible to inspectors and those that do not comply with the regulations must be held accountable.

AB 32 SUGGESTED FARM PRACTICES

- **Offsets include abatement, sequestration, and efficiency gains**
- **Abatement - removing or destroying greenhouse gases before release**
- **Livestock examples of abatement:**
 - **Converting methane gas in digesters**
 - **Biomass/biogas provides fuel or power**
 - **Feed additives may reduce methane production**

SEQUESTRATION

(These are not important for California agriculture)

- **Conservation tillage**
 - **Minimum of 30% plant residue on soil after planting**
 - **Currently employed on less than 2% of annual cropland in California**
- **Cover crops**
 - **Can improve soil health, add nitrogen, prevent wind or water erosion, or produce a forage crop**
 - **Not widely practiced in California because benefits are small and in practice it is expensive**

EFFICIENCY

- **Irrigation efficiency**
 - Reduces energy to pump water and lowers nitrous oxide (N₂O) emissions (excess irrigation can raise N₂O emissions)
- **Nitrogen use efficiency**
 - Precision farming
 - Soil sampling to tailor applications
- **Farm machinery**
 - Reduce fuel use, increase efficiency



POTENTIAL GHG REDUCTIONS FROM ALTERNATIVE CROPPING PRACTICES

- Modeled emissions reductions were mostly attributable to sequestration, but were not permanent.
- Additional decreases in N₂O emissions were more modest, but were permanent.
- Implied 25% decrease in fertilizer with up to 8% decrease in yields.

Source: De Gryze et al. (2009)

POTENTIAL GHG REDUCTIONS FROM ALTERNATIVE CROPPING PRACTICES

- **Changes in GHG emissions differed across location and crops**
 - **E.g. conservation tillage slightly increased GHG emissions for wheat (due to rise in N₂O) but decreased emissions for tomatoes**

Source: De Gryze et al. (2009)

- **That modeling considers practices for production of each crop, not potential shifts of land and between crops**

(We will come back to this point later)

POTENTIAL GHG REDUCTIONS FROM FARMING

- **The simplest way to reduce GHG emissions from farming is to reduce farm production**
- **However, reduced emissions for offsets are not the only objective of agriculture**
 - **Food, fiber and foliage remain useful contributions**
- **Therefore, it is important to consider measuring GHG reductions in terms of emissions per unit of output of a value indicator not simply per acre**

ALTERNATIVE PRACTICES FOR RICE

- **Rice is a significant GHG contributor in part because of methane emissions**
- **Anaerobic decomposition of biomass emits methane**
- **Reduce methane by:**
 - Draining fields mid-season**
 - Using less winter flooding to decompose straw residue**



ALTERNATIVE PRACTICES FOR RICE

- **Consider economics of alternative practices**
 - **Cost to growers, compensation to adopt?**
 - **Compare to GHG reductions to trace out GHG reductions per dollar of reduced returns**
- **Study nearing completion examines practices across more than six thousand fields in the Sacramento Valley**
- **The biggest cost of alternative practices is foregone production from yield reductions**

ALTERNATIVE PRACTICES FOR RICE

- **Many practices have at most modest GHG reductions**
- **Withdrawal of mid season flood water is not among the most effective practices to reduce GHG emissions per ton of rice**
- **Alternatives to reduce winter anaerobic straw decomposition seem to lower GHG emissions**
- **Substantial heterogeneity in emissions across fields by soil type in the California rice belt**

AN EFFECTIVE AB 32 MAY INCREASE GLOBAL AGRICULTURAL GHG EMISSIONS

- **AB 32 rules can lead to increased GHG emissions from global agriculture**
- **Agricultural markets are global and Californians will continue to consume food**
- **Raising costs here will shift food production out of state, and not reduce *global* emissions**
- **Production practices elsewhere are often *more* land intensive and therefore more GHG intensive**

EFFECTIVE OFFSETS PAYING FOR CHANGES IN PRACTICES CAN INCREASE CALIFORNIA GHG EMISSIONS FROM AGRICULTURE

- **Offsets for practices that are certified by crop do not account for shifting land across crops, and there are big differences by crop**
 - **If a certified practice allows payment for offsets for, say, tomatoes, that will raise tomato revenue and encourage more acres of tomatoes.**
 - **The result would likely be fewer acres of competitive crops like wheat with a net *increase* in GHG emissions from agriculture even though offsets are certified and verified**

CONCLUSIONS

- **This presentation did not address the effects of climate change on agriculture or the adaptation of agriculture to expected climate change**
- **Nor did it consider the contributions of agriculture to GHG emissions in any detail**
- **Rather, it focused on the effects of climate change *policy* on California agriculture and agriculture's potential responses to AB 32 implementation**
- **Agriculture faces the similar potential uncertainties and impacts of higher energy prices both on farming directly and through farm inputs and post harvest processing and marketing**