



Leibniz-Institut für Agrarentwicklung  
in Transformationsökonomien

# Climate change and agricultural insurance in Central Asia

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- Background
- Bio-economic modeling the impact of CC
- The role of agricultural insurance to manage CC risks
- CIS insurance market development trends

- Importance of agricultural production
- Environmental and institutional challenges
- Changing temperature and rainfall patterns
- Uncertainty of crop yields
- Price fluctuations
- Limited research on adaptation options
- Need for further research on climate change impact

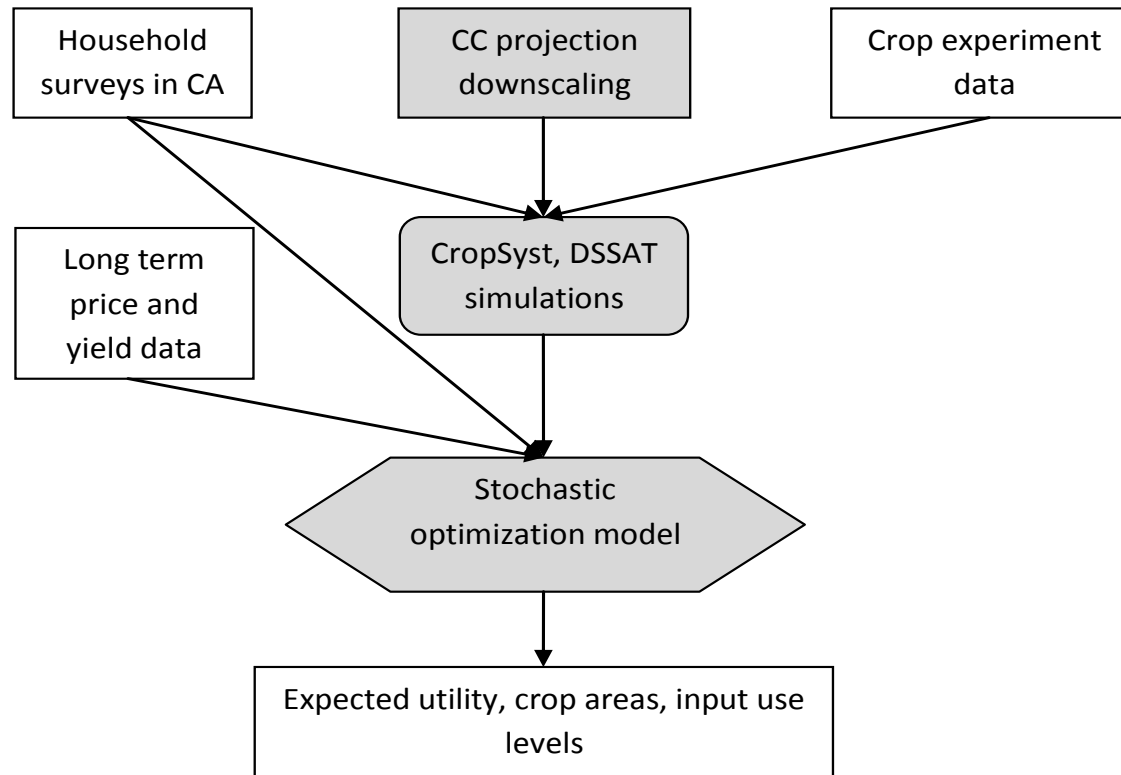
- Diversity of agro-ecological zones in Central Asia
- Heterogeneity of climate change
- High difference between farming systems
- Limited information on household level socio-economic characteristics
- Importance of irrigation water supply
- Need for farming system level analysis

## □ Mathematical programming models

- ▶ Crop models
- ▶ Hydrological modeling
- ▶ Farm models
- ▶ Regional models

## □ Statistical tools

- ▶ Cross sectional data analysis (farm, regional level)
- ▶ Panel data analysis
- ▶ Analysis of time series records (yield, income, weather extremes)



# Empirical model

- Expected Value Variance in GAMS
- Yield and management data from crop models
- AEZ data from GIS

```
gamside: C:\GAMS_old\insurance\lexinsurance...
File Edit Search Windows Utilities Help
infea
demo1.gms demo1.gms demo2.gms insmodelex.gms insmodelex.lst

;
TOBJ.. CE =e= sum((f,c), (price(c)*fxy(f,c) - (expen(c)+195*wp*wa(f,c)/coeff
(1*lam/2)*(sum(f,c), (price(c)**2)*fxv(f,c)+varprice(c)*(fxy(f,c)**

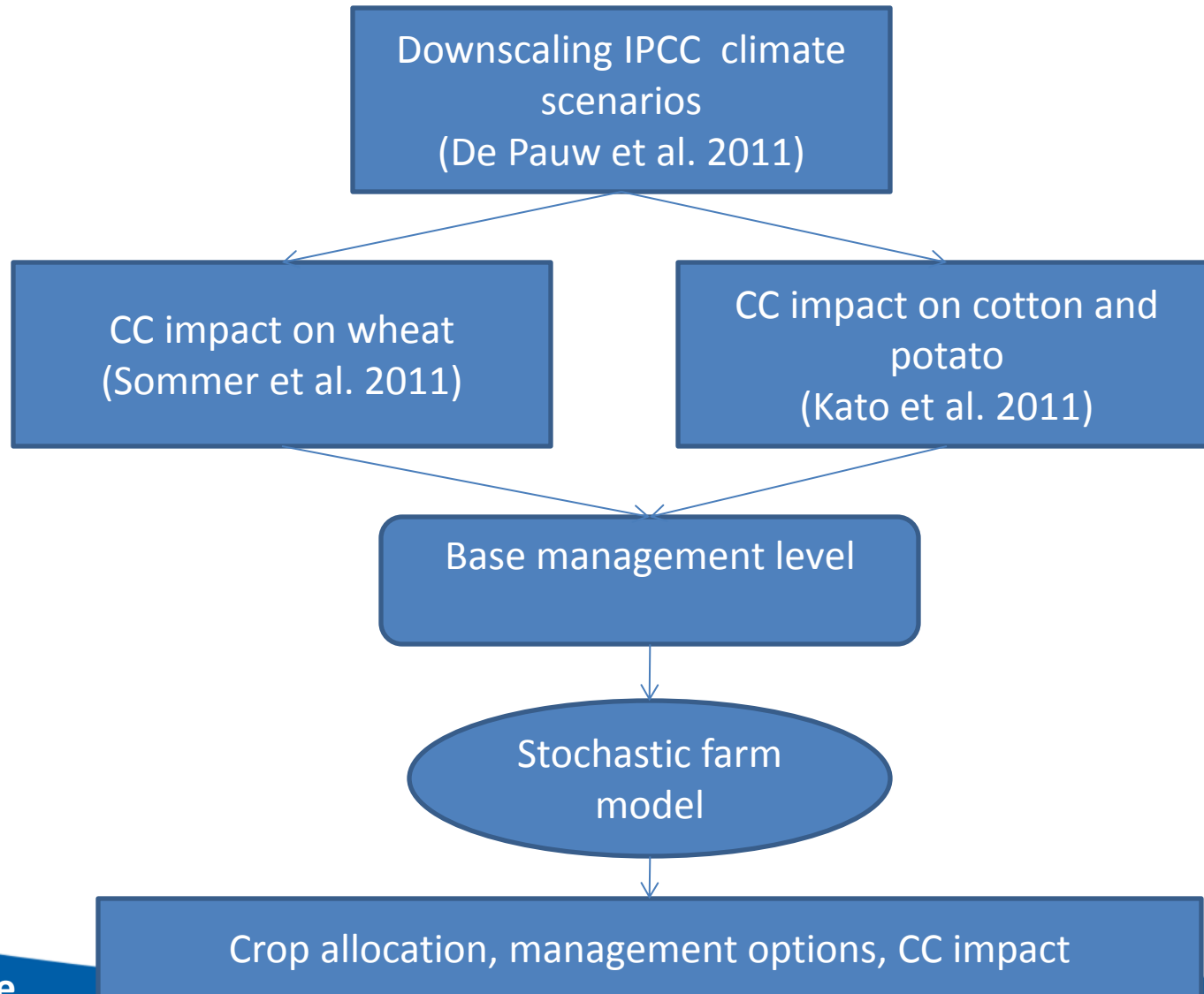
exy(f,c).. fxy(f,c) =e= betE.1(f,c,'1') + betE.1(f,c,'2')*wa(f,c) +
exv(f,c).. fxv(f,c) =e= betV.1(f,c,'1') + betV.1(f,c,'2')*wa(f,c) +
cova(f,c).. covar(f,c) =e= corpy(c)*stdevprice(c)*sqrt(sqrt(sqr(fxv(f,c)

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avl(fr).. sum(f$ftofr(fr,fr), sum(c, lab(c)*ha(f,c))) =1=leb*fattrib(fr);
cott(fr).. sum(f$ftofr(fr,fr), ha(f, "cot")) =g= fattrib(fr)*stoc;
wht(fr).. sum(f$ftofr(fr,fr), ha(f, 'wv')) =g= fattrib(fr)*stow;

model shamEV
/
TOBJ
exy
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```

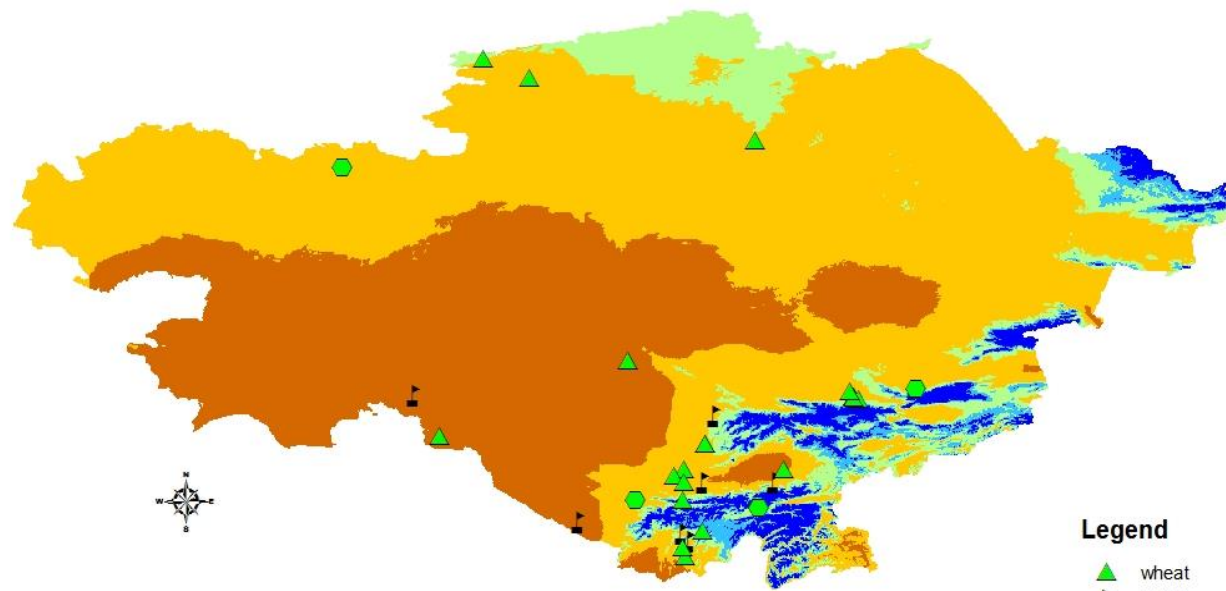
The screenshot shows the ArcMap - ArcView interface. The title bar reads "shama - ArcMap - ArcView". The menu bar includes File, Edit, View, Insert, Selection, Tools, Window, and Help. The toolbar contains various icons for file operations and navigation. The Layers panel on the left shows a list of layers, with "farm2002\_w" selected. The ArcToolbox panel in the center lists various tool categories such as Analysis Tools, Cartography Tools, Conversion Tools, Data Management, Geocoding Tools, Linear Referencing, and Spatial Statistics. The map view on the right displays a colorful map of a region with various land use patterns.

The screenshot shows the CropSyst Suite 4 software interface. The title bar reads "CropSyst Suite 4". The menu bar includes About, Instructions, Simulation projects, and Utilities. The main window displays a colorful collage of agricultural scenes, including a field of corn, a field of wheat, a field of soybeans, and a field of rice. The text "CropSyst" is prominently displayed in the center of the collage. Below the collage, the text "CropSyst Suite" and "Claudio Stöckle and Roger Nelson" is visible. The bottom status bar shows "Version: 4.08.03" and "Web page".





# Location of crop experiment stations in different AEZs

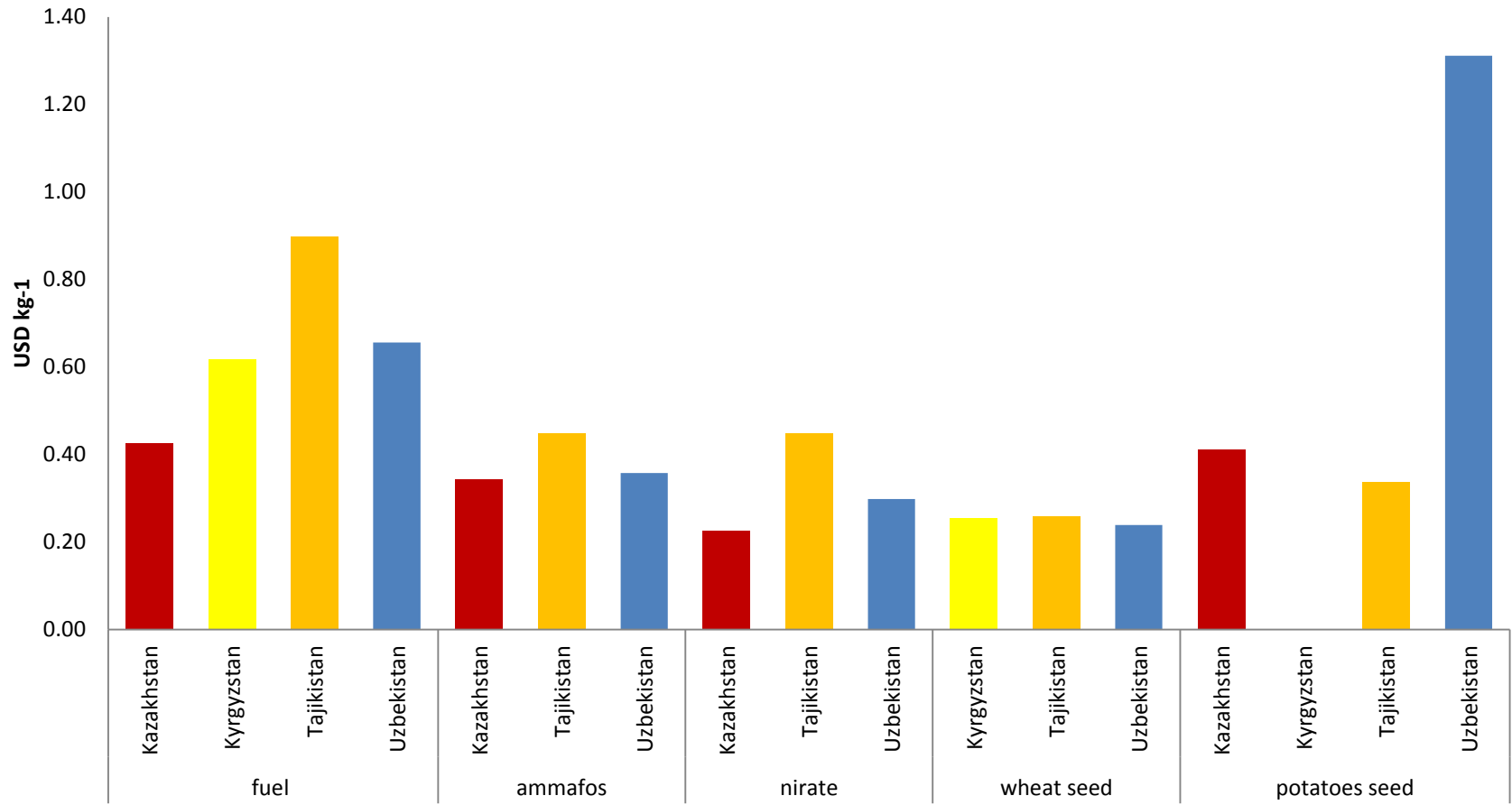


## Legend

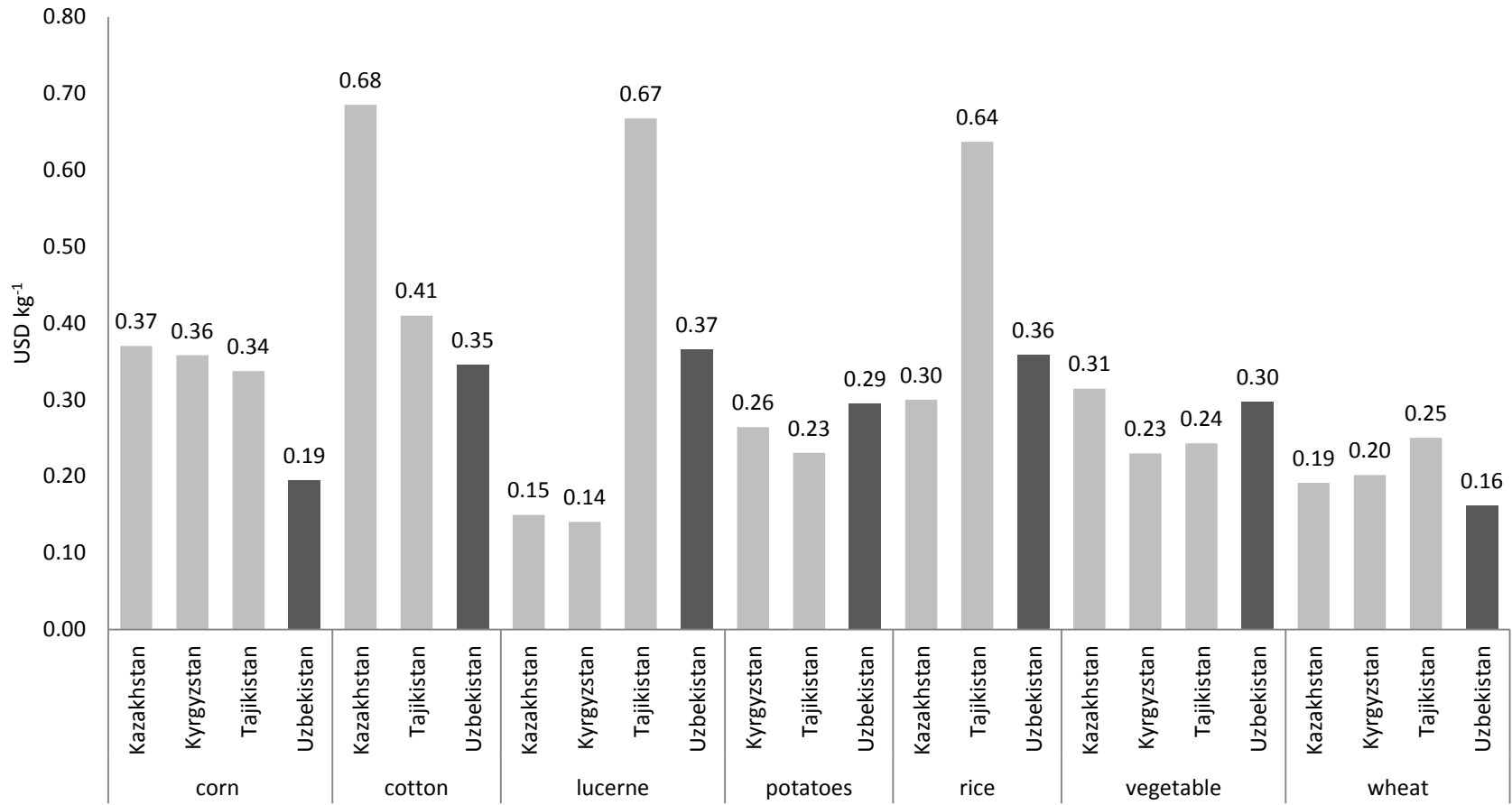
- ▲ wheat
- ▲ cotton
- potato
- arid
- semiarid
- subhumid
- humid
- perhumid

| Country           | AEZ      |
|-------------------|----------|
| <b>Kazakhstan</b> |          |
| 1                 | arid     |
| 2                 | semiarid |
| 3                 | subhumid |
| <b>Kyrgyzstan</b> |          |
| 4                 | subhumid |
| 5                 | semiarid |
| <b>Tajikistan</b> |          |
| 6                 | arid     |
| 7                 | semiarid |
| 8                 | humid    |
| <b>Uzbekistan</b> |          |
| 9                 | arid     |
| 10                | semiarid |

# Input price differences between the countries



# Farm gate output price differences between the countries

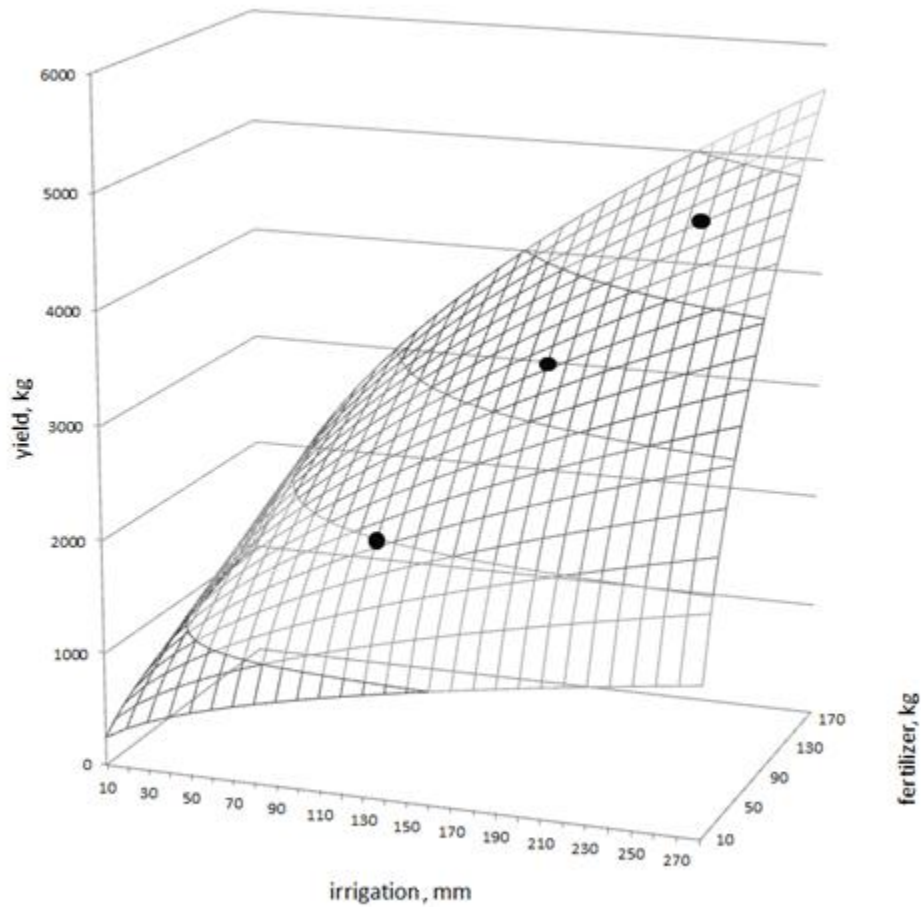


# Scenarios management options

| Scenario Nr. | Period        | Emission Scenario |
|--------------|---------------|-------------------|
| 1            | current, base | none              |
| 2            | 2010-2040     | A1b               |
| 3            | 2070-2100     | A1b               |
| 4            | 2010-2040     | A2                |
| 5            | 2070-2100     | A2                |

| Management               | crop   | Description   |
|--------------------------|--------|---|
| Poor management (pmn)    | wheat  | 0-80 kg of fertilizer, 0-120 mm of irrigation water depending on AEZ(without irrigation under rainfed conditions) |
|                          | cotton | 100-120 kg fertilizer depending on AEZ  |
|                          | potato | 100-120 kg fertilizer depending on AEZ  |
| Average management (amn) | wheat  | 25-30% more fertilizer (depending on a country), 30-50% more water<br>than poor management                        |
|                          | cotton | 5 tons of organic fertilizer  |
|                          | potato | 5 tons of organic fertilizer  |
| Good management (gmn)    | wheat  | 40-50% more fertilizer (depending on a country), 60-70% more water<br>than poor management                        |
|                          | cotton | 50% more fertilizer   |

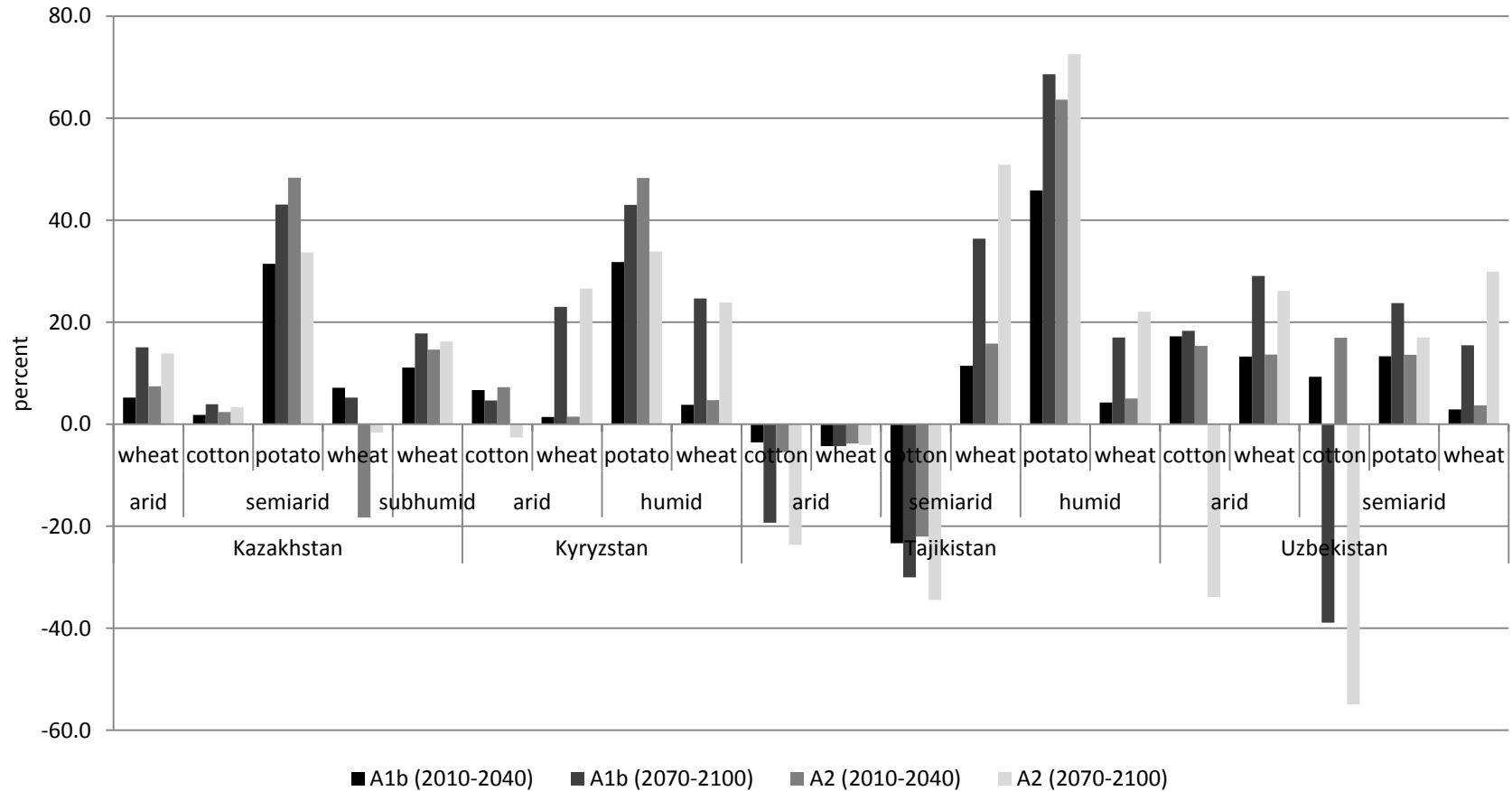
# Illustration of production function



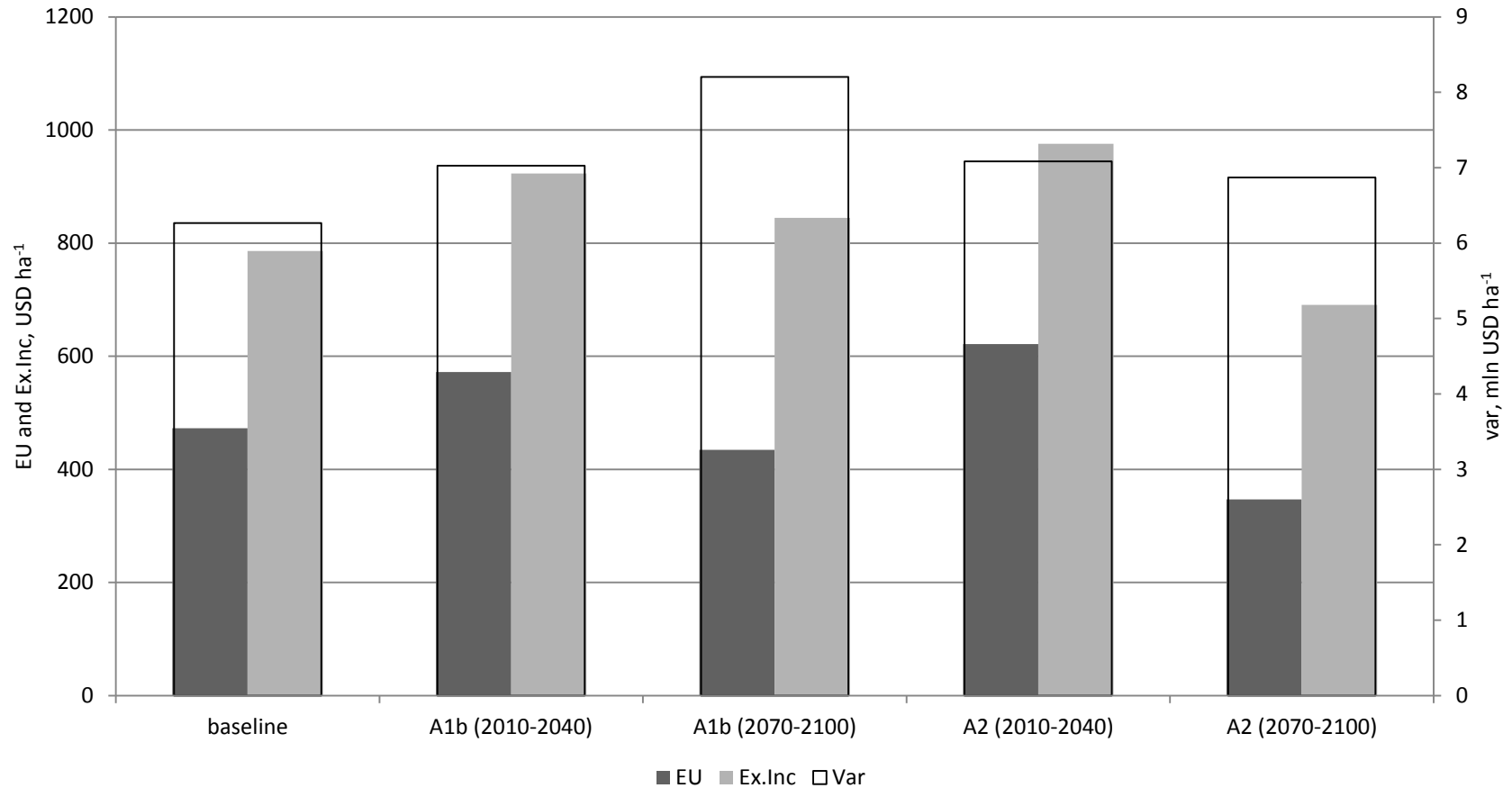
# Mean annual temperature and precipitation changes

|                   | A1b 2010-2040 |             | A2 2010-2040 |             | A1b 2070-2100 |             | A2 2070-2100 |             |
|-------------------|---------------|-------------|--------------|-------------|---------------|-------------|--------------|-------------|
|                   | Temp., °C     | Precip., mm | Temp., °C    | Precip., mm | Temp., °C     | Precip., mm | Temp., °C    | Precip., mm |
| <b>Kazakhstan</b> |               |             |              |             |               |             |              |             |
| <b>arid</b>       | 1,3           | 8,4         | 1,4          | 9,3         | 3,6           | 11,5        | 4,4          | 5,3         |
| <b>semiarid</b>   | 1,3           | 12,9        | 1,4          | 16,5        | 4             | 27,7        | 4,8          | 19,8        |
| <b>subhumid</b>   | 1,3           | 10          | 1,5          | 16          | 4,2           | 25,3        | 5,1          | 11,9        |
| <b>Kyrgyzstan</b> |               |             |              |             |               |             |              |             |
| <b>semiarid</b>   | 1,3           | 6,6         | 1,4          | 8,4         | 3,6           | 22,7        | 4,2          | 19,3        |
| <b>subhumid</b>   | 1,3           | 8,1         | 1,4          | 10          | 3,6           | 36,5        | 4,2          | 36,3        |
| <b>Tajikistan</b> |               |             |              |             |               |             |              |             |
| <b>arid</b>       | 1,3           | 6,2         | 1,5          | 8,3         | 3,7           | 9,7         | 4,3          | 2,7         |
| <b>semiarid</b>   | 1,4           | 8,6         | 1,5          | 21          | 3,8           | 13          | 4,4          | 7,3         |
| <b>Uzbekistan</b> |               |             |              |             |               |             |              |             |
| <b>arid</b>       | 1,3           | 7,7         | 1,3          | 12,6        | 3,5           | 12,7        | 4,1          | 10,4        |
| <b>semiarid</b>   | 1,3           | 14,9        | 1,4          | 18          | 3,6           | 25,4        | 4,2          | 17,1        |

# Crop yield changes under average input use levels

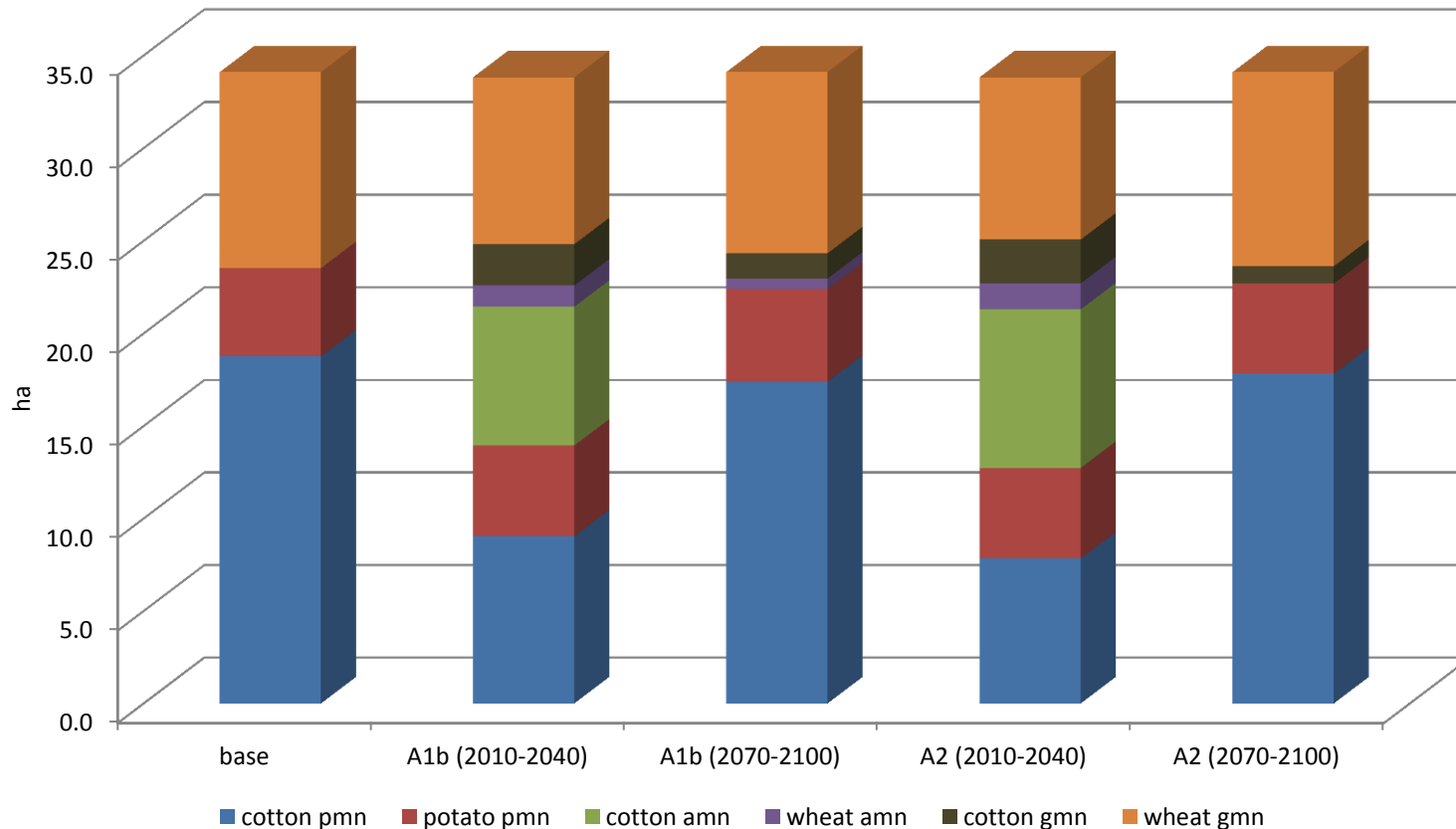


# Expected utility under different scenarios in semiarid, Uzbekistan



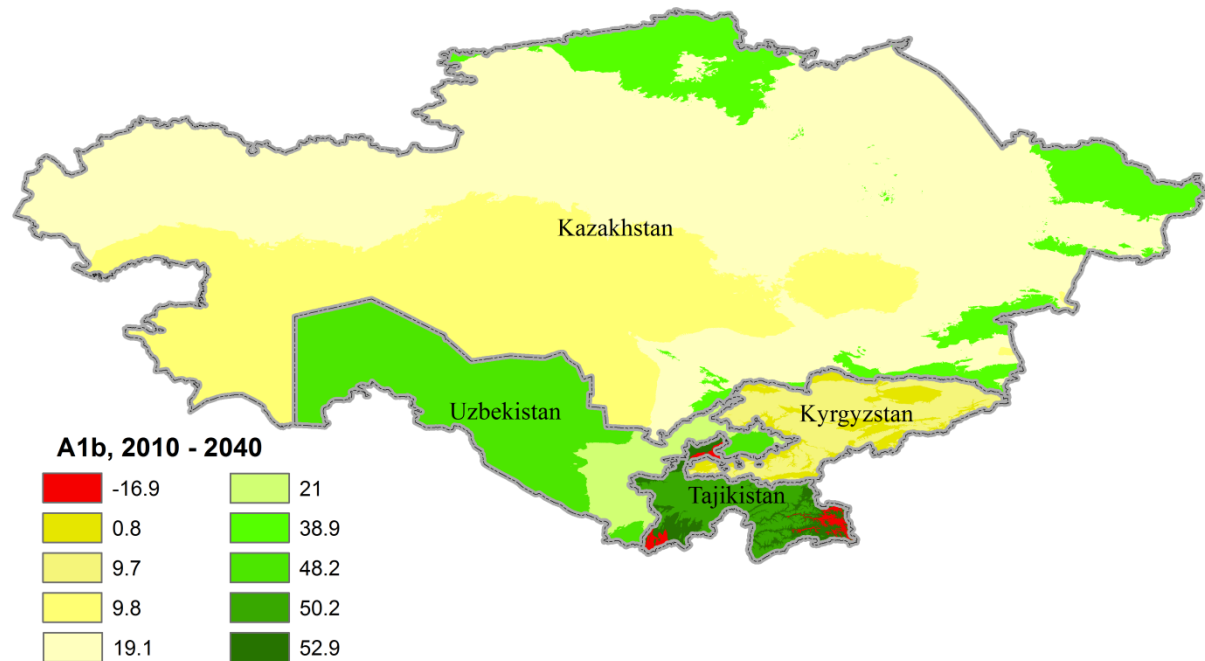


# Allocation of crops with different management options, semiarid zone Uzbekistan

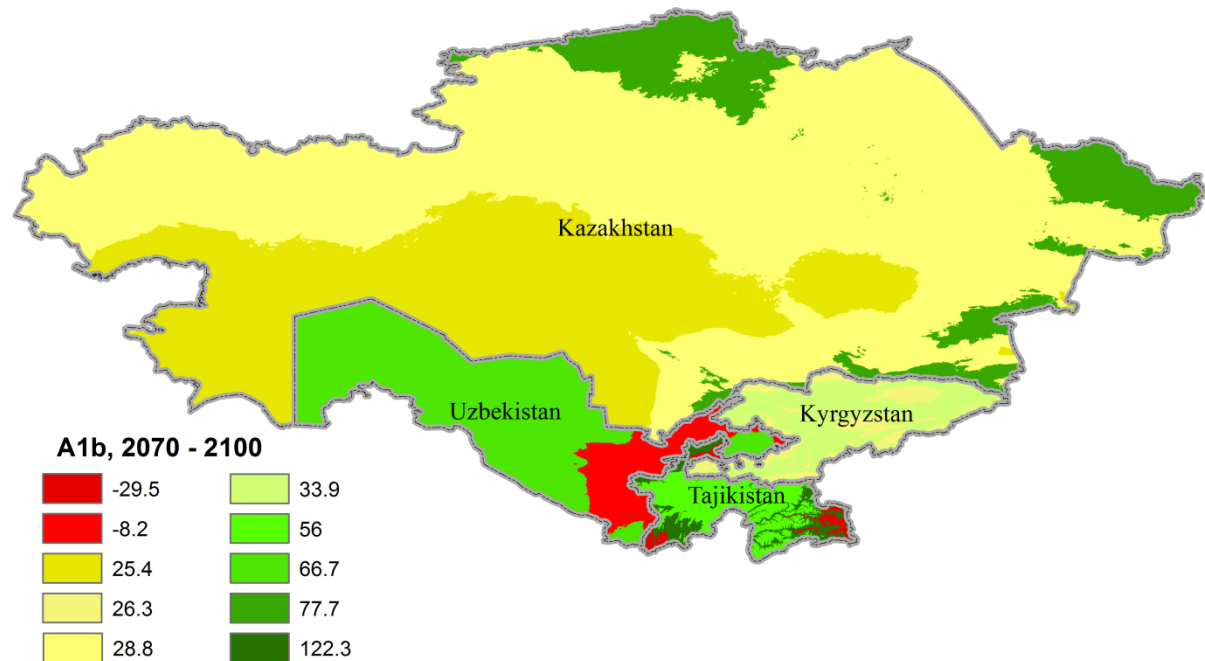


*Note: pmn-poor management, amn- average management, gmn- good management*

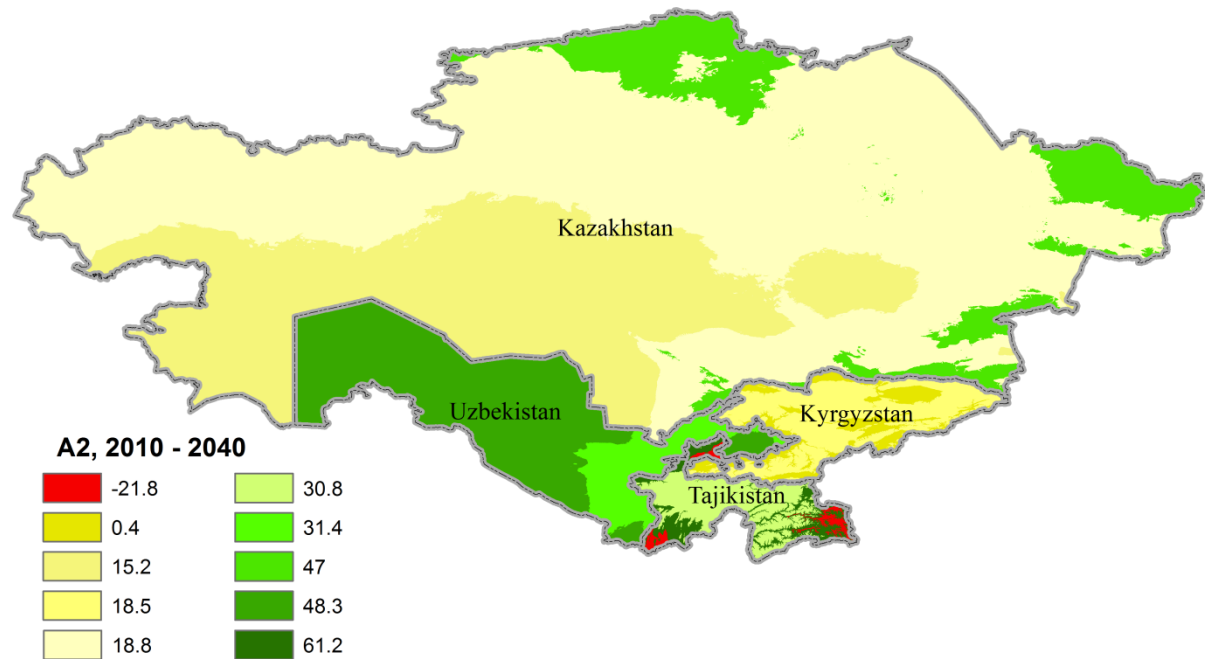
# Change of expected farm income under A1b for the period 2010-2040



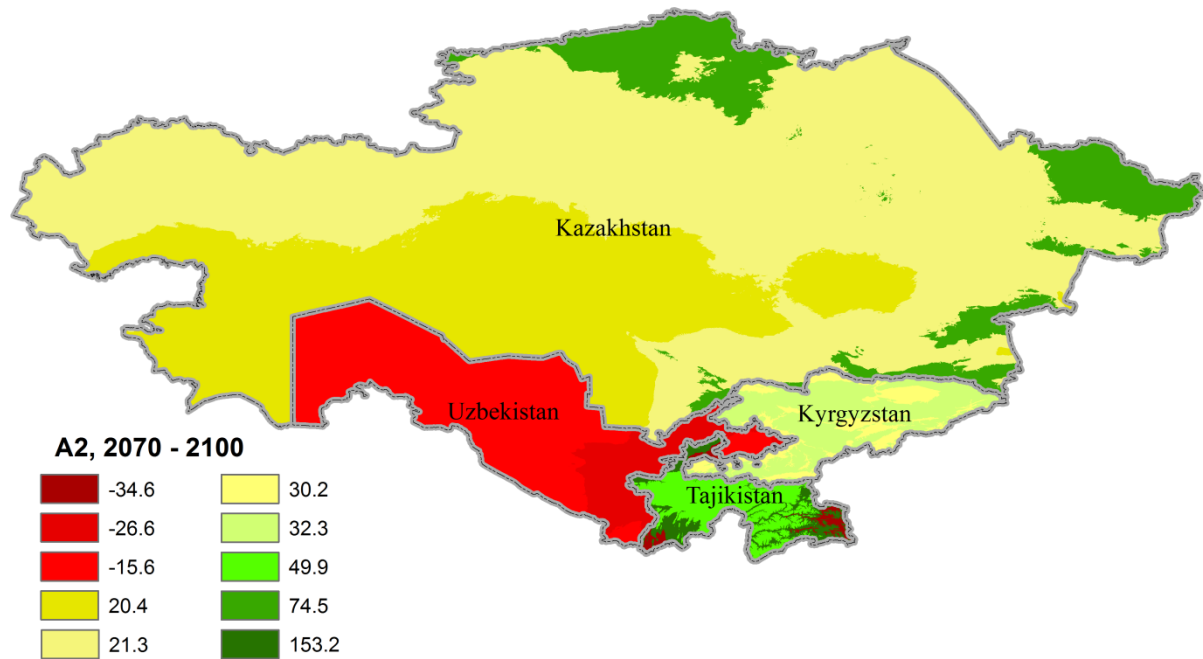
# Change of expected farm income under A1b for the period 2070-2100



# Change of expected farm income under A2 for the period 2010-2040



# Change of expected farm income under A2 for the period 2070-2100



# Changes under water scarcity scenario, in percentage

|                   |          | A1b (2010-2040) | A1b (2070-2100) | A2 (2010-2040) | A2 (2070-2100) |
|-------------------|----------|-----------------|-----------------|----------------|----------------|
| <b>Kazakhstan</b> | arid     | -11,6           | 1,7             | -5,4           | 0,1            |
|                   | semiarid | 3,2             | 11,1            | 2,7            | 4              |
|                   | subhumid | 38,9            | 77,7            | 47             | 74,5           |
| <b>Kyrgyzstan</b> | semiarid | -14,6           | 7,3             | -14,5          | 11,3           |
|                   | subhumid | 5,6             | 24,6            | 14,3           | 22,4           |
| <b>Tajikistan</b> | arid     | -28             | -30,1           | -30,7          | -34,6          |
|                   | semiarid | 49,5            | 122,3           | 58,8           | 153,2          |
|                   | humid    | 17,1            | 29,5            | 13,2           | 30             |
| <b>Uzbekistan</b> | arid     | 14,7            | 25,5            | 15,1           | -57,5          |
|                   | semiarid | 10,7            | -25,5           | 21,2           | -42,6          |

# Changes under market integration to the baseline scenario, in percentage

|                   |          | A1b (2010-2040) | A1b (2070-2100) | A2 (2010-2040) | A2 (2070-2100) |
|-------------------|----------|-----------------|-----------------|----------------|----------------|
| <b>Kazakhstan</b> | arid     | 10,6            | 24,7            | 17,2           | 23,2           |
|                   | semiarid | 2,7             | 9,1             | 2,1            | 1,8            |
|                   | subhumid | 63,7            | 105,3           | 72,4           | 101,7          |
| <b>Kyrgyzstan</b> | semiarid | 17,1            | 18,9            | 14,8           | 18,6           |
|                   | subhumid | 22,7            | 43,5            | 31,1           | 41,7           |
| <b>Tajikistan</b> | arid     | 199,6           | 190,4           | 190            | 178,1          |
|                   | semiarid | 61,8            | 116,4           | 69             | 139            |
|                   | humid    | 44,5            | 43,4            | 21,3           | 36,3           |
| <b>Uzbekistan</b> | arid     | 327,5           | 339,4           | 324,5          | 122,5          |
|                   | semiarid | 229,3           | 106,6           | 258,3          | 65,7           |

- CC impacts on agricultural systems differently
- High differences between the scenarios
- Higher losses under A2 than A1b scenario
- Positive impact in the North
- Negative impact in the South
- Irrigation water decline may bring very high losses to Uzbekistan and some regions of Tajikistan
- Market integration will help to cope with climate change in the long run
- Insurance market needs to be developed in the short run to enable investment into adaptation technologies



- Provide payments when losses occur
- Enable access to credits
- Increase investment confidence
- Improve productivity
- Increase risk coping potential
- Better food security for rural and urban population
- → *What are the potential contributions of insurance in the CIS countries*

- Mandatory insurance by “Gosstrakh” during the Former Soviet Union (FSU)
- Collapse of the state insurance mechanisms after independence
- Emergence of semi-state insurance companies in several countries: Kazakhstan, Russia, Ukraine and Uzbekistan
- Lack of agricultural insurance markets in the remaining states
- High interest of international organizations and governments to establish insurance markets in some regions (e.g. Azerbaijan, Armenia and Tajikistan).

# Comparison between Kazakhstan and Russia

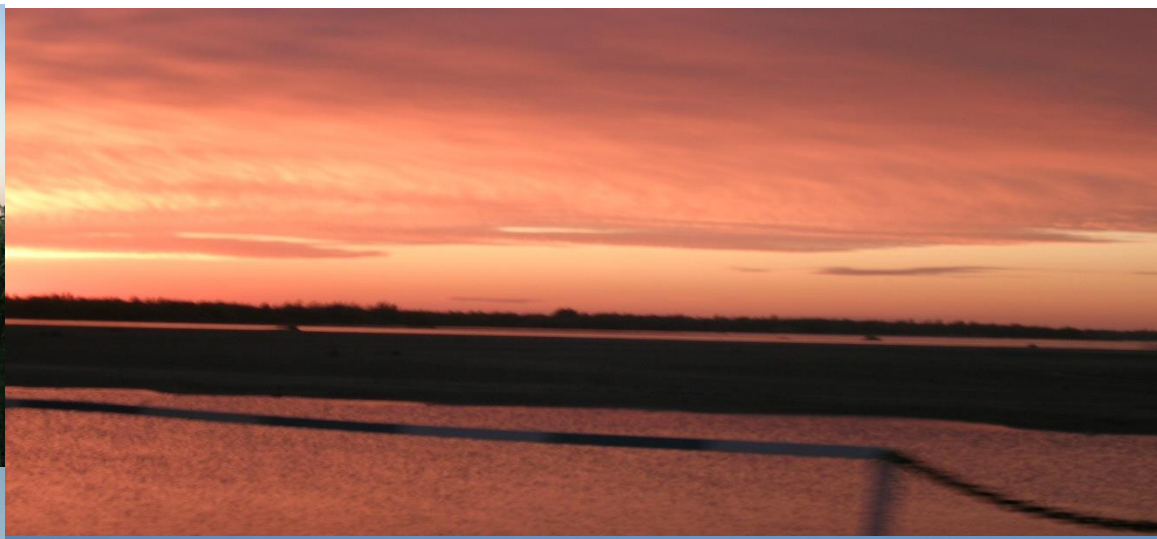
| <b>Kazakhstan</b>              | 2005         | 2006         | 2007         | 2008         | 2009         | 2010         |
|--------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Numer of contracts, thousand   | 19           | 13,6         | 25,4         | 34           | 32,2         | 16,8         |
| Total crop area, mln. Ha       | 18,4         | 18,4         | 19,0         | 20,1         | 21,4         | 21,4         |
| Insured area, mln. Ha          | 10,5         | 9,1          | 12,1         | 14,5         | 15           | 12,7         |
| <b>Insured area, percent</b>   | <b>56,93</b> | <b>49,54</b> | <b>63,84</b> | <b>72,07</b> | <b>70,01</b> | <b>59,24</b> |
| Liability, mnl. Tenge          | 34,372       | 26,65        | 34,796       | 46,645       | 52,903       | 47,266       |
| Premiums, mln. Tenge           | 899          | 685          | 997          | 1,093        | 1,114        | 1,074        |
| Premium rate                   | 0,0261       | 0,0257       | 0,0287       | 0,0234       | 0,0211       | 0,0227       |
| Indemnity payments, mln. Tenge | 1,065        | 478          | 701          | 1,71         | 1,465        | 2,805        |
| <b>Los ratio</b>               | <b>1,19</b>  | <b>0,7</b>   | <b>0,7</b>   | <b>1,56</b>  | <b>1,31</b>  | <b>2,61</b>  |

| <b>Russia</b>                | 2009         | 2010         | 2011         | 2012         | 2013         |
|------------------------------|--------------|--------------|--------------|--------------|--------------|
| Number of contracts          | 7121         | 5528         | 7003         | 7123         | 6741         |
| Total crop area, mln. ha     | 64,7         | 67           | 70,8         | 69,7         | 71,7         |
| Insured area, mln. ha        | 11,8         | 8,3          | 14,2         | 12,9         | 11,7         |
| <b>Insured area, percent</b> | <b>18,24</b> | <b>12,39</b> | <b>20,06</b> | <b>18,51</b> | <b>16,32</b> |
| Total liability, mln. Rub    | 119127       | 87983        | 136573       | 175473       | 183128       |
| Total premiums, mln. Rub     | 9184,3       | 8805,8       | 13735,9      | 9699,9       | 10653        |
| Indemnity payments, mln. Rub | 4480,4       | 6392,4       | 3865,4       | 2181,5       | 1454,5       |
| <b>Loss ratios</b>           | <b>0,488</b> | <b>0,726</b> | <b>0,281</b> | <b>0,225</b> | <b>0,137</b> |

# Uzbek ag-insurance market

| Market Indicators  | 2003        | 2004        | 2005        | 2006        | 2007        | 2008        | 2009        | 2010        | 2011        | 2012        |
|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Volume of insurance premiums under the agroinsurance contracts (mln. Sum)    | 2904,7      | 3187,4      | 3419,3      | 3857,6      | 5374,8      | 7274        | 6754,6      | 5640        | 6405,4      | 8840,8      |
| Volume of insurance liabilities under the agroinsurance contracts (mln. Sum) | 296900,4    | 354778,6    | 188469,5    | 226046,8    | 329330,9    | 290200      | 256400      | 291300      | 455600      | 628300      |
| Volume of indemnities under the agroinsurance contracts (mln. Sum)           | 629,9       | 1022,3      | 762,5       | 1433        | 1980,2      | 2740        | 3217        | 1898        | 1846        | 2948        |
| Loss ratio under agroinsurance contracts, %                                  | <b>21,7</b> | <b>32,1</b> | <b>22,3</b> | <b>37,1</b> | <b>36,8</b> | <b>37,7</b> | <b>47,6</b> | <b>33,7</b> | <b>28,8</b> | <b>33,3</b> |

- Lack of insurance markets in the countries without state support
- Profit maximization of insurance companies under state support , the lack of transparency
- High importance of informal institutions determining the benefits from insurance products
- Need for product diversity
- Need for establishment of pilot projects with alternative insurance products (e.g. index-insurance)



**Thank you for your attention!**

