PROJECT

Transboundary water management adaptation in the Amudarya basin to climate change uncertainties

Report
2.8.3 Testing the module for calculation of foodstuff in PZ

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1. Testing the module for calculation of foodstuff in planning zone.
2. The model of planning zone is developed in GAMS (Version 24.5.6) with the use of MINOS5 solver. Methodology of the program: the module receives input data from the database. Then the program is calibrated in the following way: using the actual data on cropping pattern in PZ, as well as yield coefficients, coefficients of conversion into feed mass and feed units, the forage for meat production is calculated, with following calculation of meat and dairy output. Variable pasture coefficient is inputted to determine consumption of forage produced in non-irrigated agriculture. Coefficients determining consumption of roughage and soft feed are inputted. Using these data, a system of linear equations with target function is constructed: standard deviation of the simulated meat and dairy output from the actual output (Annex 1). This is required for adjustment of the coefficients against the actual data and to prepare them for the following stage of optimization of cropping patterns in PZ.
3. Data were received from SIC ICWC for simulation experiment. The data is for Khorezm for 2014 (Annex 2).
4. As shown in Annexes 3.1 and 2.3, the difference between the actual and the simulated output of vegetables is 15% and this is a norm. Annex 2 shows that this difference comes from the data on Khorezm for 2014.

   It is also obvious that in order to reduce the difference, it is necessary to consider also non irrigated agriculture (Annex 2.4).

   A pasture coefficient influences largely meat output (Annex 3.2); thus, non-irrigated agriculture is very important for meat production.

Annexes:

Annex 1.
Short description of the computer program:
Input data of the program includes the actual cropping patterns, yield coefficients, feed mass coefficients, and feed conversion ratio. Gross output of crops is calculated, as well as unit parameters of foodstuff production.

$$FactAmountCrops \ = \ Fact\_Area\_Crops \ * \ productivity$$

$$SpecificFactAmountCrops \ = \ Fact\_Area\_Crops \ * \ productivity \ / \ Population$$

$$Calibration\_Feed\_Unit \ = \ FeedUnitCoef \ * \ Fact\_Area\_Crops \ * \ productivity \ * \ FeedMassCoef \ *10000$$

$$Feed\_Cal \ = \ \sum FeedUnitCoef\_feedcrops \ * \ Fact\_Area \ * \ productivity \ * \ FeedMass \ * \ 10000$$

$$Roughage\_Cal \ = \ \sum FeedUnitCoef\_RoughageCrops \ * \ Fact\_Area \ * \ productivity \ * \ FeedMass \ * \ 10000$$

To calculate dairy and meet production, variable coefficients are inputted to consider pastures and calculated when solving the optimization problem:

$$\begin{cases} FeedUnitPastureCal \ = \ \sum Calibration\_Feed\_Unit \ * \ PastureCoefCal \\ PastureMilkCal \ = \ FeedUnitPastureCal * CoefCalibration / (CoefCalibration + 1) \\ PastureMeatCal \ = \ FeedUnitPastureCal / (CoefCalibration + 1) \\ PercentRoughageMeat \ = \ Roughage\_Cal \ - \ Roughage\_Cal \ * \ PercentRoughage / 100 \\ PercentFeedMeat \ = \ Feed\_Cal \ - \ PercentFeed * Feed\_Cal / 100 \ + \ PastureMeatCal \\ \Pr odMilkCal = \ MilkUnit * ((TotalRoughage * PercentRoughage / 100 + PercentFeed * TotalFeed / 100) + PastureMilk) / 1000000 \\ \Pr odMeatCal \ = \ \sum \Pr odMeatByCattle / 1000 \\ Spec \Pr odMeatCal \ = \ \Pr odMeatCal * 1000 / Population \\ Spec \Pr odMilkCal \ = \ \Pr odMilkCal * 1000 / Population \\ DeviationCal \ = \ (\Pr odMeatCal \ - \ Fact \Pr odMeat)^2 \ + \ (\Pr odMilkCal \ - \ Fact \Pr odMilk)^2 \\ DeviationCal \rightarrow \min \end{cases}$$

Where the following parameters are inputted and permanent:
$Fact\_Area\_Crops$ - actual distribution of areas
$productivity$ - crop yields
$Population$ - population in a planning zone
$FeedMassCoef$ - coefficient of conversion into feed mass
$Calibration\_Feed\_Unit$ - quantity of feed mass

And the following parameters are variable and subjected to optimization and then serve as input for the next phase as permanent parameters, where cropping patterns are to be optimized to achieve food security:
$CoefCalibration$ - coefficient of forage consumption
$PercentFeed$ - coefficient of soft feed consumption
$PercentRoughage$ - coefficient of roughage consumption
$PastureCoefCal$ - pasture coefficient

Annex 2.1

Net area	247.5
Area under crop:	226.7

Crop	Area under crop	Sown area	Double-season crops	Yield
	ths ha	ths ha	ths ha	t\ha
Cotton	93.8	93.8		2.752
Wheat	33.2	33.2		3.783
Rice	7.4	7.4	2.656	2.365
Maize for grain (corn)	0.95	0.95		2.653
Vegetables	26.17	26.17	15.936	13.407
Fruits		13.62		11.652
Forage	7.1	7.1	7.968	3.958
Homestead plot	11.8	11.8		
Other	32.65	32.65		

Homestead crop:	Orchards and vegetables	Orchards and vegetables
	%	ths ha
Orhcard	30	3.54
Vegetables	70	8.26

Crop	Actual production output:	Foodstuff	Actual production output:
	ths t		ths t
Orchard	137.1	Meat	72.5
Grain	125.6	Dairy	816.1
Maize	2.52	Bread	143.1
Melons	101.25	Fruits	199.9480176
Potato	108.3	Vegetables	461.5882881
Rice	17.5	Oil	
Vegetables	141.3	Sugar	
Grapes	21.6	Eggs, million	331

Livestock	
Animals	Number of heads
Cattle	755,600
Sheep	379,900

Annex 2.2

Crop	Actual production output	Simulated production output	Deviation
	ths t	ths t	%
orchard	137.1	158.7	0%
grape	21.6		
homestead plot	0	151.9863057	-100%
maize	2.52	2.52	0%
melons	101.25	421.02	-17%
potato	108.3		
vegetables	141.3		
rice	17.5	23.78108108	-26%
sugar beet	0	0	0%
grain	125.6	125.6	0%

Annex 2.3

Foodstuff	Actual production output:	Simulated production output:	Deviation
	ths t	ths t	%
Meat	72.5	72.5	0.00%
Dairy	816.1	816.1	0.00%
Bread	143.1	144.85	1.22%
Fruits	199.9480176	199.95	0.000991%
Vegetables	461.5882881	531.78	15.21%
Oil			
Sugar			
Eggs, million	331		

Annex 2.4

Pasture coefficient	2.99
Coefficient of roughage consumption	99
Coefficient of soft feed consumption	1

Annex 3.1. Comparison of simulated and actual output

Comparison of simulated and actual output
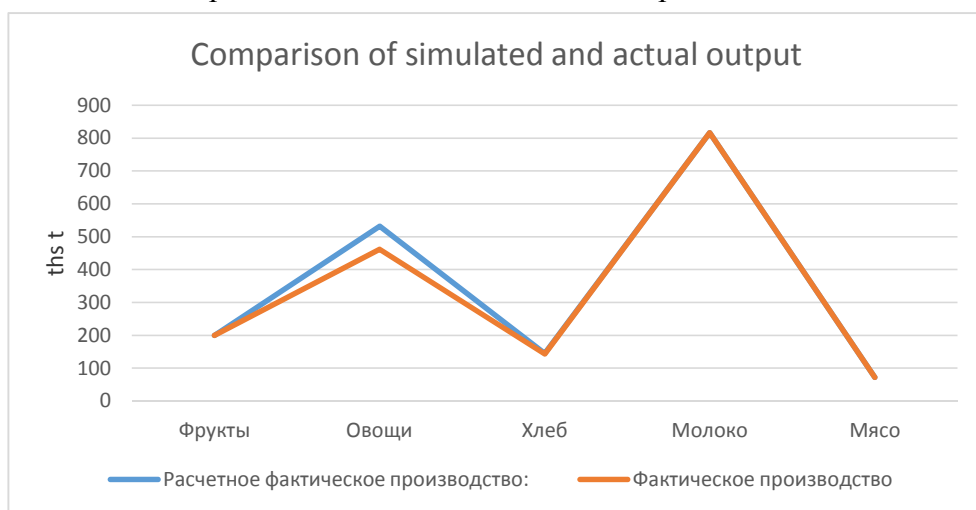
Annex 3.2. Dependence of meat production on pasture coefficient

Dependence of meat production on pasture coefficient