Greenhouse gas accounting of

Community-based Agriculture Support Program plus (CASP+)

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Background

This assessment was undertaken as part of the Food and Agriculture Organization (FAO) of the United Nations-project “Low carbon and resilient livestock development strategies for climate informed investments” (read more). The project aims to support International Fund for Agricultural Development (IFAD)-funded projects in Kyrgyzstan, Lesotho, Rwanda, Malawi, Brazil, Uzbekistan, Georgia and Tajikistan to develop and implement strategies that will improve livestock production while reducing the GHG emissions and improving resilience of farmers. This report presents the results for the CASP+ in Tajikistan.

The assessment was carried out using the Global Livestock Environmental Assessment Model-*interactive* (GLEAM-*i*), a tool developed by FAO to measure emissions from livestock value chains and compare the impact of future scenarios. The guidelines (FAO, 2021) and the technical videos providing in-depth information about how to use the tool can be found at GLEAM resources page (read more). The three major GHGs covered in the tool are methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2). The global warming potential used to convert CH_4 and N_2O to CO_2 equivalents (CO_2e) were 27 and 273, respectively (IPCC, 2021). GLEAM-*i* covers life cycle emissions from the production of inputs up to the farm gate. The details regarding the sources of emissions (Table 1) can be found in the model description (FAO, 2017) (read more) or in a previously published report for Kyrgyzstan (IFAD & FAO, 2021).

Table 1. Sources of emissions captured in GLEAM-*i*

Sources of emissions		**Description**
Enteric fermentation (CH_4)		CH_4 emissions caused by enteric fermentation
Manure management (CH_4)		CH_4 emissions caused by manure management
Manure management (N_2O)		N_2O emissions arising from manure storage and management
Direct energy use of production facilities (CO_2)		CO_2 emissions arising from energy use on-farm for e.g. lighting, ventilation, washing, cooling, heating and milking
Indirect energy use from capital goods (CO_2)		CO_2 emissions arising from energy use during the construction of machinery, tools and equipment, buildings e.g. animal housing, forage and manure storage
Feed production and processing (CO_2)	Field operations	CO_2 emissions arising from the use of fossil fuels during field operations
	Fertilizer production	CO_2 emissions from the manufacture and transport of synthetic nitrogenous, phosphate and potash fertilizers
	Pesticide production	CO_2 emissions from the manufacture, transport and application of pesticides
	Processing and transport	CO_2 generated during the processing of crops for feed and the transport by land and/or sea
	Blending and pelleting	CO_2 arising from the blending of concentrate feed
Land use change	Soybean cultivation	CO_2 emission due to LUC associated with the expansion of

(LUC) to expand feed production (CO_2)		soybean
	Palm kernel cake	CO_2 emission due to LUC associated with the expansion of palm oil plantations
Manure, fertilizer and crop residues for feed (N_2O)	Applied and deposited Manure	Direct and indirect N_2O emissions from manure deposited on the fields and used as organic fertilizer
	Fertilizer and crop residues	Direct and indirect N_2O emissions from applied synthetic nitrogenous fertilizer and crop residues decomposition
Rice as feed (CH_4)	Rice production	CH_4 emissions arising from the cultivation of rice used as feed *(not relevant for this analysis)*

CH_4: methane, N_2O: nitrous oxide, CO_2: carbon dioxide

Approach

Data collection and validation

Data for the assessment were collected through consultations with the State Enterprise “Project Management Unit - Livestock and Pasture Development” (SEPMU) of the Ministry of Agriculture, and based on national statistics and on the Monitoring data of the IFAD-funded Livestock and Pasture Development Project (LPDP), phases I and II (Cavatassi and Gemessa 2022).

Production systems

Three production systems exist in the project target area:

i) Grassland-based dairy cattle
ii) Grassland-based meat sheep
iii) Grassland-based meat goat

Scenarios

Three scenarios were developed.

Baseline. This scenario represents the year that the project is expected to start (i.e. year 0).

With Project (WP). This scenario represents the situation with improvements made via the project to herd structure, as well as herd management and feeding over the project timeline. The time horizon of the projection is based on the overall project life cycle selected for CASP+, including 7 years of implementation and 20 additional years for the capitalization. The animal numbers were projected for year 7 (project duration), year 14, and year 27 of which the latter is assumed to be the capitalization phase.

The scenario WP represents the impact of a package of measures comprising of improved breeding through artificial insemination (AI) (for cattle) and distribution of improved bulls and rams, improved animal health through improved access to private veterinary services and vaccination (e.g. *Brucellosis* for sheep and goats), treatment for internal and external parasites, improved animal husbandry through hands on training of farmers, pasture management including rotation and restoration, and improved availability and quality of feed.

Without Project (WOP). This is the business-as-usual scenario (i.e. baseline). It was assumed that the parameters in this scenario still improve by time but at a lower level than the scenario WP.

Comparing the WP and WOP scenarios reveals the expected impact of the project on GHG emissions. The results are presented per annum basis as well as cumulatively at year 7, 14 and 27 for total emissions and total protein production.

Assumptions

Animal numbers

The animal numbers used in the project assessment are provided in Table 2 below. In CASP+, it is expected that the herd sizes will continue to grow, due mainly to the lack of financial services not allowing farmers to save in another form than livestock. Changes in animal numbers in the assessments apply to the herd size, therefore, number of adult females was calculated using the expected herd size and herd parameters. Calculation of the number of adult males is based on a male to female ratio of 1:10 in all species. Aimed herd size reflects the % changes applied to each scenario. The reason for not reducing number of males to reflect the impact of AI is because farmers usually do not keep bulls for breeding purposes and cows are mated with young bulls kept for meat purposes, therefore, it was foreseen that the AI would not change the number of adult males in the scenario WP. The results reflect the herd size calculated by GLEAM-*i*.

Table 2. Animal numbers used in the assessment

		Baseline	**WP Y7**	**WOP Y7**	**WP Y14**	**WOP Y14**	**WP Y27**	**WOP Y27**
			7% increase from baseline	14% increase from baseline	7% increase from Y7	8% increase from Y7	10% increase from Y14	10% increase from Y14
Cattle	Adult female	135,081	137,500	152,000	144,000	159,000	156,000	171,000
	Adult male	13,508	13,750	15,200	14,400	15,900	15,600	17,100
	GLEAM-*i* herd	355,709	380,466	405,007	407,086	437,862	447,265	481,304
	Aimed herd	355,709	380,608	405,508	407,251	437,949	447,976	481,744
Sheep	Adult female	194,794	196,300	224,000	200,500	238,100	213,500	258,500
	Adult male	19,479	19,630	22,400	20,050	23,810	21,350	25,850
	GLEAM-*i* herd	417,951	451,481	484,178	487,863	528,975	545,160	591,170
	Aimed herd	417,951	451,387	484,823	487,497	528,457	545,997	591,871
Goats	Adult female	104,889	104,000	121,400	105,700	127,500	113,000	140,500
	Adult male	10,489	10,400	12,140	10,570	12,750	11,300	14,050
	GLEAM-*i* herd	253,593	273,185	294,757	295,262	320,230	331,487	359,158
	Aimed herd	253,593	273,880	294,167	295,790	320,642	331,285	359,120

Table 3 and Table 4 show the input data used in all systems, red text referring to the changed made in scenario WP in CASP+ and LPDPII assessments, respectively.

Herd, feed and manure parameters are presented in Table 3.

Table 3. Herd, feed and manure parameters used in CASP+ assessment. Project targets WP in red

Parameters		**Year 0**			**Year 7**			**Year 14**			**Year 27**		
HERD	**Unit**	**Cattle**	**Sheep**	**Goats**	**Cattle**	**Sheep**	**Goats**	**Cattle**	**Sheep**	**Goats**	**Cattle**	**Sheep**	**Goats**
Age at first parturition	months	27.6	16	15	27.6 27.6	16 16	15 15	27.6 27.6	16 16	15 15	27.6 27.6	16 16	15 15
Death rate of adult animals	%	6	10	9.3	5.7 4.8	9.6 8	9.2 7.4	4.8 4.2	8.2 7	7.4 6.8	3 3.8	7.4 6.5	7.2 6.5
Death rate of young animals	%	12	15	15	11.5 9.6	14.8 12	14.8 12	9.5 8.3	11.7 10	11.7 10	8.5 7.6	10.6 9	10.3 9
Fertility rate of adult females	%	12	74.5	83.9	11.5 9.6	75 78.2	84 88.1	9.5 8.3	78.5 81	87 90	8.5 7.6	82.3 83	89 91
Litter size	number	70	1.2	1.1	71.2 73.5	1.2 1.3	1.1 1.2	73 75	1.2 1.4	1.1 1.3	74.5 76	1.2 1.5	1.1 1.4
Live weight of adult females	kg	350	58.8	38	355 385	59 60.6	38.1 39.1	385 400	60.8 62	39.2 40	400 410	61.5 63	40 40.5
Live weight of adult males	kg	450	98.1	58.6	460 495	98.7 101	58.9 60.4	500 520	102 103	60.4 61	520 535	102.8 104	60.8 61.5
Live weight of meat females at slaughter	kg	350	50	35	355 385	50.5 51.5	35.4 36.1	385 400	51.8 52.5	36.2 36.6	400 410	52.7 53	36.7 36.8
Live weight of meat males at slaughter	kg	350	85	50	355 385	85.9 87.6	50.5 51.5	385 400	88 89	51.8 52.5	400 410	89.3 90	52.7 53
Milk fat	%	4.1	-	-	4.1 4.1	-	-	4.1 4.1	-	-	4.1 4.1	-	-
Milk protein	%	3.5	-	-	3.5 3.5	-	-	3.5 3.5	-	-	3.5 3.5	-	-
Milk yield	kg/year	600	-	-	660 780	-	-	820 960	-	-	920 1100	-	-
Parturition interval	days	-	365	287	-	365 365	287 287	-	365 365	287 287	-	365 365	287 287
Replacement rate of adult females	%	25	14.9	21.3	25 25	14.9 14.9	21.3 21.3	25 25	14.9 14.9	21.3 21.3	25 25	14.9 14.9	21.3 21.3
Weight at birth	kg	25	5.3	3	25.8 27.5	5.4 5.5	3.0 3.1	28 29	5.5 5.6	3.1 3.2	29.3 30	5.6 5.7	3.2 3.2
FEED													
By-products from cottonseed	%	3	0	0	3 5	0 2	0 2	3 5	0 2	0 2	3 5	0 2	0 2
Crop residues from wheat	%	25	25	25	24 20	24 20	24 20	20 17	21 17	20 17	18 15	19 15	16 15
Fodder beet	%	4	3	3	4 5	3 3	3 3	4 5	3 3	3 3	4 5	3 3	3 3
Fresh grass	%	60	65	65	58 50	64 59	64 59	55 45	60 55	61 55	50 40	56 52	58 52
Fresh mixture of grass and legumes	%				0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2

Hay or silage from alfalfa	%	1	1	1	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2
Hay or silage from grass and legumes	%	6	6	6	9 12	8 12	8 12	16 20	15 19	15 19	23 27	21 24	22 24
Silage from whole grain plants	%				0 1			0 1			0 1		
Silage from whole maize plant	%	1			1 3			1 3			1 3		
MANURE													
Burned for fuel	%	20	20	20	20	20	20	20	20	20	20	20	20
Pasture/Range/Paddock	%	40	40	40	40	40	40	40	40	40	40	40	40
Solid storage	%	40	40	40	40	40	40	40	40	40	40	40	40

Results

Results show that total emissions (per annum) reduced by about 2% at year 7, 5% at year 14, and 7% at year 27, respectively in the scenario WP compared to the scenario WOP. This was a reduction from 1,509,066 t (WOP) to 1,476,242 t (WP) CO_2e/year at year 7, from 1,739,777 t (WOP) to 1,645,823 t (WOP) CO_2e/year at year 14, and from 1,998,878 t (WOP) to 1,864,502 t (WP) CO_2e/year at year 27. Annual protein production increased by 7% from 7,663 t (WOP) to 8206 t/year (WP) at year 7, by 4% from 9,668 t (WOP) to 10,024 t/year (WP) at year 14, and by 2% from 11,780 t (WOP) to 12,038 t (WP) at year 27. The increase in protein production WP at year 27 was about 90% of that of the baseline reflecting both increased number of animals and increased productivity. Emissions intensity of all systems reduced by 9% in scenario WP compared to the scenario WOP in all years. Feed intake was around 2%, 5% and 6% lower WP than WOP at year 7, 14 and 27, respectively (Figure 1).

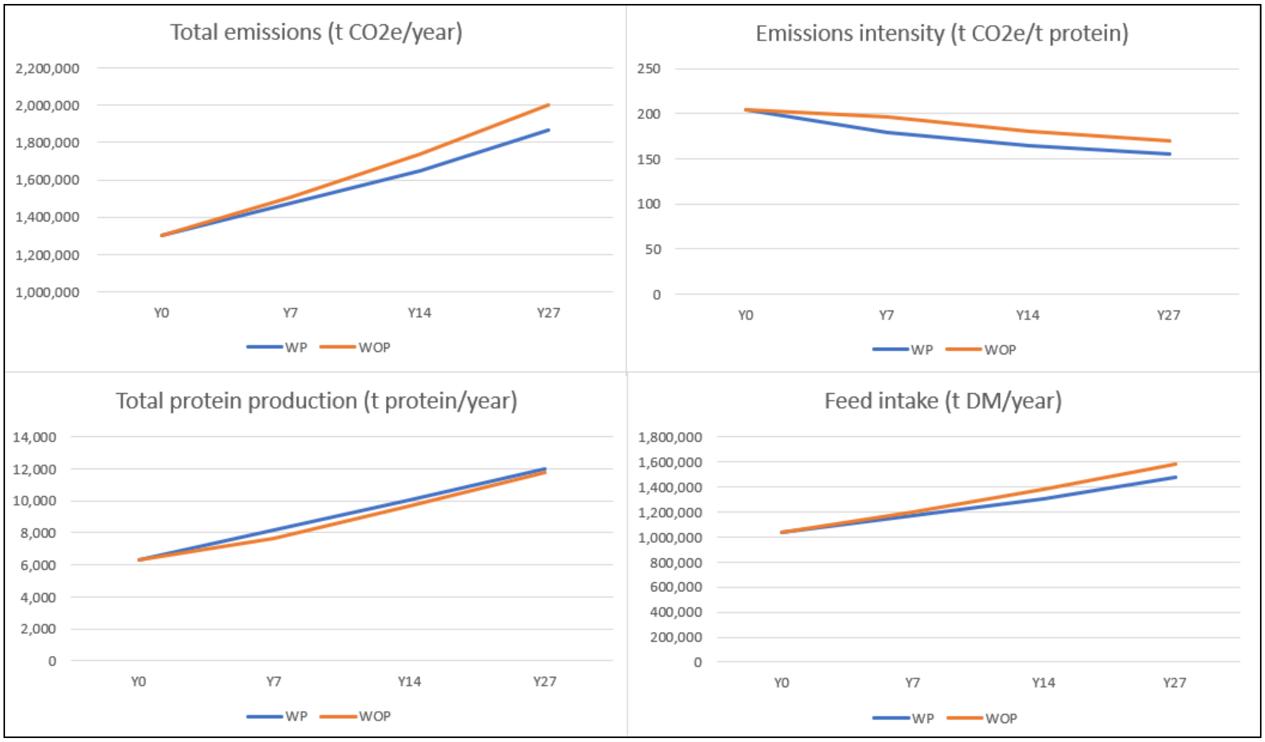

Figure 1. Total emissions, emissions intensity, total protein production and feed intake at different years (per annum)

When the cumulative net incremental emissions were calculated over the course of 7 years (i.e. project period) and 27 year (capitalization phase), it was found that the project could save a total of 1,317,171 t CO_2e emissions and produce an incremental 4,824 t protein (i.e. difference between emissions WP and WOP per year multiplied by 3.5 for years 1-7, 3.5 for years 8-14, 6.5 for years 15-27 assuming a linear increase between WP and WOP).

Breakdown of emissions revealed that 52% of the total emissions came from CH_4 due to enteric fermentation, followed by CO_2 emissions from feed (41%), and CH_4 and N_2O emissions from manure management (3% each), and finally CO_2 coming from energy use (1%). This distribution of different GHGs did not change by scenarios (Figure 2), however, there were differences in quantities by different scenarios (Table 4).

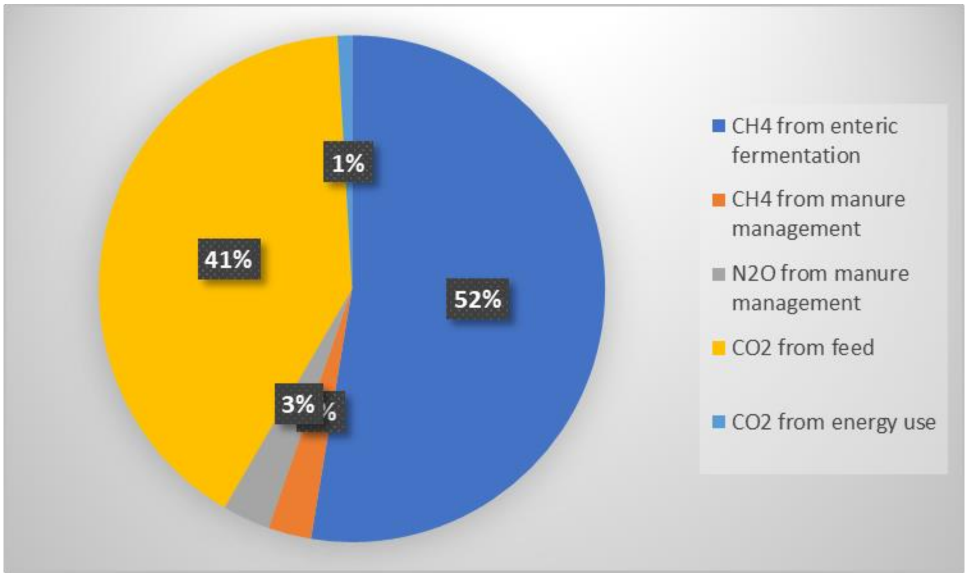

Figure 2. Breakdown of emissions in CASP+ (baseline)

Table 4. Breakdown of emissions

Emission sources	Baseline	WPY7	WOPY7	WPY14	WOPY14	WPY27	WOPY27
CH_4 from enteric fermentation	588,677	664,953	682,195	739,709	782,776	837,454	898,667
CH_4 from manure management	30,828	34,611	35,762	38,600	41,019	43,834	47,184
N_2O from manure management	34,244	40,614	39,890	45,833	46,669	52,455	54,320
CO_2 from feed	455,160	517,327	527,762	577,328	611,811	653,436	702,707
CO_2 from energy use	10,301	13,249	12,403	16,180	15,494	19,491	18,665

Reflections and recommendations

Technical entry points

A combination of measures was implemented in terms of herd management and feeding practices in this study. Some practices may be implemented individually (i.e. not part of a package) and only for a selected number of beneficiaries, leading to results that are different than those reported here.

Herd level

i) Increasing the fertility rate leads to more meat animals. Number of calving and calves increase. As a result, the herd size increases.

ii) Reducing the death rate of animals means that more meat animals become available to produce meat. Lower death rate of adult females leads to fewer replacement. Overall, herd size increases.

iii) Increasing weight at different life stages leads to more meat leaving the farm.

Project should focus on improving animal health and reproductivity of animals, improving accessibility and quality of animal health services, treatment of external and internal parasites, vaccination, in addition to a selective breeding program that does not only use exotic breeds (even though the breeding program in the project focusses only on exotic breeds) but also the traits of the local breeds that can withstand extreme weather conditions.

Feed level

Smallholder farmers currently mostly rely on pasture for feeding their animals, including in winter. The project will promote the cultivation and conservation (hay and silage) of improved fodder crops, either as main crops, or in combination with other crops (inter-cropping, catch crops). This will be achieved through a combination of activities such as demonstration on fodder cultivation and conservation, hands on training, dissemination of productive and climate resistant crop varieties, and provision of equipment for cultivation and harvesting.

Project can benefit from exploring opportunities to improve availability of maize for small ruminants and increasing use of crop residues from maize and by-products from cottonseed in all species. Maize yields will depend on the increases in daytime temperatures. Climate-proofing of maize production by developing maize varieties that can withstand water stress and can mature early and early planting can be considered. Alternatives to feed more fodder beet to all species can be explored further. Pasture resting, rotational grazing on seasonal pastures or designated paddocks, protection of water resources and managing herd growth to align stocking rate with the changing biomass availability, in addition to implementing better quality fodder production will be good practices to implement.

Manure level

The manure management is part of the Pasture Management Plans even though no particular investment is envisaged at individual farmer level since the financial system serves at collective level. With the current structure of the way the manure is managed (i.e. 40% deposited on pastures, 40% stored in solid form, and 20% is burnt for fuel), the system is already producing low levels of emissions associated with manure management. Without changing the way the manure is managed, i.e. not storing in liquid form, efficiency gains can be achieved through herd and feed management.

CH_4 emissions may be higher when manure is stored in liquid form, while N_2O emissions may be higher in dry-lot or solid systems (read more). However, emissions from manure are usually low in most systems where manure is stored in solid form.

Project is already achieving efficiency gains with the current form of manure management. Additional proportions of manure composted are not likely to reduce emissions from manure management. On the contrary, if a share of manure currently burned for fuel or deposited on pastures is instead composted, this would increase the emissions. Spreading manure daily can reduce emissions slightly more, but it may not be practical or financially viable.

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