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Discussion Paper No. 651

"Utilization of Agriculture Residues and Livestock Waste in Uzbekistan"

Toderich K., Massino I., Shoaib I., Tsukatani T., Khujanazarov A., Rabbimov A., Kuliev T., Boboev H., Aralova D. and Usmanov S.

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Nowadays local farmers in Uzbekistan prefer to use traditional and low-cost technologies for recycling the livestock manure through anaerobic and aerobic biodigestion and by direct application as organic fertilizer. The livestock waste treatment technique, however, are still too simple and improving is going insignificant. Fuel wood in the arid zones of Uzbekistan is often scarce as a result of deforestation and range degradation, leading to the ever-increasing role of animals as providers of manure for fuel. Biomass utilization for biogas production is a promising direction of energy, and Uzbekistan in its agrarian sector has a big potential of biomass energy in the amount of 0.3 million ton of oil equivalent. Energy generated from biomass may satisfy 15-19% of energy needs of Uzbekistan. 15 improved lines tested by ICBA in Uzbekistan showed perspectives of sorghum stover for bioethanol production.

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Utilization of Agriculture Residue and Livestock Waste in Uzbekistan

Toderich K., Massino I., Shoaib I., Tsukatani T., Khujanazarov A., Rabbimov A., Kuliev T., Boboev H., Aralova D. and Usmanov S.

Abstract:

In Uzbekistan, the integration of crops and livestock, and the use of manure as fertilizer, are traditional practices and is the basis of the farming systems, especially at smallholder level. Nowadays local farmers prefer to use traditional and low-cost technologies for recycling the livestock manure through: anaerobic biodigestion (biodigesters); aerobic biodigestion (composting) and by direct application as organic fertilizer. The livestock waste treatment technique, however, are still too simple and improving is going insignificant. The monitoring system of manure composition, or its allocation to the drop fields is not completely developed. Fuel wood in the arid zones of Uzbekistan is often scarce as a result of deforestation and range degradation, leading to the ever-increasing role of animals as providers of manure for fuel, in addition to means of transport. Phasing out of energy subsidies has also caused that livestock manure, is not returned to the land, but used for heating and cooking, because alternative energy sources are no longer available or affordable. A number of local initiatives on improving waste management procedures waste processing enterprise are implemented in different cities.

Biomass has been also a traditional energy source for the production of biogas, and a promising direction of energy in the agrarian sector of Uzbekistan. Uzbekistan has a big potential of biomass energy in the amount of 0.3 million ton of oil equivalent. Energy generated from biomass may satisfy 15–19 % of energy needs of Uzbekistan. Such method of energy production will also resolve the environmental protection issues: use of methane gas considerably reduces CO_2 emission into the atmosphere. Besides, the biological residue of the process will provide the country's agriculture with high quality fertilizers. Biogas installations have already been tested at a stock-breeding farm "Milk Agro" in Zangiota village of Tashkent region. Practical results are already achieved: the farm is using biogas for its electricity and heating needs, fertilizers were put on the farm's fields

Uzbekistan has also a big potential for production of bioethanol from crop residues and wasted crops: rice straw, wheat straw and corn stover are the most favourable bioethanol feedstock. 15 improved lines tested by ICBA (International Centre for Biosaline Agriculture) in Uzbekistan showed perspectives of sorghum stover for bioethanol production.

Key words:

assessment, agriculture residues, bio-ethanol, bio-gas, marginal lands, livestock waste, Uzbekistan, Central Asia

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Introduction

The economy of Uzbekistan is based primarily on agriculture and agricultural processing with cotton and wheat being the major export crops. This dependence of the economy on agrarian based activities is unlikely to change in the foreseeable future. The Central Asian countries, Uzbekistan particularly face three major challenges: ensuring food security, alleviating poverty and environmental protection (Beniwal and Warma, 2000). There are approximately 284 million ha of agricultural lands in Central Asia. Each of the five countries has its own agricultural specialization (Table 1).

Table 1 Distribution of agricultural land of Central Asia

2005 data in 1000 hectares

Land Use	Countries					
	Kazakhstan	Uzbekistan	Kyrgyzstan	Turkmenistan	Tajikistan	Total
Land area	269,970	42,540	19,180	46,993	13,996	392,679
Agricultural area	207,598	27,890	10,745	33,065	4,255	283,553
Arable land	22,364	4,700	1,284	2,300	930	31,578
Meadows and pastures	185,098	22,850	9,389	30,700	3,198	251,235
Inland water	2,520	2,200	810	1,817	259	7,606
Total	687,550	100,180	41,408	114,875	22,638	966,651

Source: FAO STAT 2008.

In hectares

Countries	year	irrigated area	% of cultivated	salinized area
Kazakhstan	1993	3,556,400	10.3	242,000
Kyrgyzstan	1994	1,077,100	80.2	60,000
Tajikistan	1994	719,200	93.4	115,000
Turkmenistan	1994	1,744,100	99.4	652,290
Uzbekistan	1994	4,280,600	82.2	2,140,550
Total		11,377,400		3,209,840

Source: FAO STAT 2008.

Among 11.38 million ha of irrigated lands of Central Asian region, half (4.28 million ha) is located in Uzbekistan, i.e. Uzbekistan has more irrigated lands than Turkmenistan, while Kazakhstan has more than all the other republics. Uzbekistan has more salinized area from irrigation than all other republics combined. Forest area in Central Asia covers only 3 % of the total area, where Kazakhstan covers only 1.2 %. At the present time the Central Asian countries; however, faces a serious challenge to its natural resource base. Croplands, rangelands and mountains are becoming degraded. The reduced availability of agricultural inputs, and feed and fodder, is resulting in a decline in livestock numbers. Water scarcity and misuse are compounding the threat to food security, human health and ecosystems. Population growth associated with expansion and intensification of agricultural activity, however, leads to the degradation of irrigated croplands, rain fed foothills and desert rangelands, where grazing, firewood collection and harvesting of medicinal plants are the main activities.

Livestock husbandry is the second key in the economy of Uzbekistan. Karakul sheep, goats, camels, horses and other animals (more than 9.0 million heads), inhabit desert-pastoral regions that provide funds for the republic as meat at 20 %, milk at 10 %, wool at 40 %, sheepskin, wool at 35,0 %, and karakul pelts at almost 98%. Livestock wastes are produced almost exclusively from karakul sheep, horse, poultry and cow-calf enterprises on arid/semiarid pasture and range systems.

The major factors for future development of feeding system in Uzbekistan may include: the incentives to farmers and their security (in terms of land, other production factors and technical skills); the availability and efficient use of feed and fodder resources; access to and the efficiency of local and nearby international markets; the ability of the agro-processing sector to transform resources and livestock products into attractive preservable consumer products; the need to understand and collect data on farm operations and structure during the economic transaction; the need to produce and process crops/animals products in a way that will improve, rather than burden the environment. Alternative agricultural production systems may assist in utilizing the marginal resources, provide economic returns, and environmental benefits to the farmers and agropastoralists in the remote arid areas. With proper screening and evaluation, non-conventional halophytes and salt tolerant crops can become an integral component in local farming production systems where water and/or soil salinity occurs.

Potential for sorghum development

Uzbekistan has a big potential producer of bioethanol from crop residues and wasted crops: rice straw, wheat straw and corn stover are the most favourable bioethanol feedstock. Research introduction of sorghum in Uzbekistan dates back to the late 1940th. Sorghum bicolor as a C4 crops, under the irrigated agricultural and rainfed zones of Central Asia, is largely cultivated as fodder crop and as feed for human consumption by the rural poor, mostly in the remote desert and semidesert marginal areas (Alekseeva 1959, Dzhabarov, 1961, Artykov, 1965, Masseno, 1982, 2004, 2006). This gramineous crop grows on diverse soil types and in a variety of climatic conditions and is well adapted to extreme marginal salt/affected; waste/abandoned with shortage water resources environments. Previous investigations showed that sorghum as cereal alternatives grows well, where other crops generally fail completely. Despite of its highly economical value the area under its cultivation as a percentage of total cereals is relatively low, i.e. less than 3, 8%. During mid 1990 there was a considerable decrease in sorghum area in Uzbekistan and Turkmenistan due to decline in its consumption (Tursunbaev et al, 1977). The cultivation of sorghum in the irrigated zones of all Central Asian countries was replaced by other crops like cotton, wheat, alfalfa and vegetables, while the area and production of sorghum has been renovated during the last decades. It appears that sorghum is again becoming popular due to its adaptability to harsh climatic semiarid conditions with poor soil fertility.

Previous studies showed that the productivity of sorghum differs between the countries and regions within the country with varying rainfall, soil type and level of salinity. Dual-purpose crops (grain and fodder), where the crop-livestock (mixed) farming system is widely practiced, is considered as one of the important livelihood strategies of rural communities and farmers. Dual-purpose sorghum under irrigated summer season is usually taken up as a second crop after early legumes or wheat. Under the condition of intensification of agriculture and, consequently, increasing of salinization there would be a huge demand for sorghum grain in future for animal feed because there is no sufficient production of maize to be used in animal nutrition. Introduction and development of early-maturing dwart genotypes will fit in intercropping systems based on low canopy crops, like soybean and others legumes. Recently research is going on for selection of sweet sorghum and exploring opportunities for ethanol production from sweet sorghum (Masseno, 2006). Potentially promising seems to be the planting of sorghum in early spring (February-March) ensures high fodder yield on the saline/degraded sandy desert rangelands (Toderich, unpublished data).

As a sugar-bearing crop, Sorghum bicolor has emerged both in Uzbekistan and International policy circles as a high potential feedstock for bio-ethanol production. The research infrastructure, however, that would support a rapid scaling up of sugar-bearing varieties/improved lines of Sorghum plantations in Central Asian countries is currently not in place. Achievable sugar content, stover and seed yields are still uncertain, and little is known about the incentive structures under which smallholder farmers would grow this plant for smaller/and larger companies, which would make investments in ethanol extraction.

A pilot study of ICBA (International Centre for Biosaline Agriculture) in collaboration with local institutions and farmers was conducted in 2006-2007 under arid/semiarid saline environments of Central Asia. Dual-purpose trials were established under different eco-agroclimatic zones, which differ in soil salinity level: 1- low or slightly (1.5-3.5 dS/m) saline serosems (Zangiota farm, Tashkent region) and salt-affected sandy desert lands (Kyzylkesek site at the Madaniyat Sherkat Farm, Navoi region) in Uzbekistan; 2- moderately saline (6-8 dS/m) that was the case at Galaba Farm, Syrdarya province (Uzbekistan) Asht massive, Sogd region (Tajikistan) and Makhtaral Experimental Plot (South Kazakhstan). Farmers grow some field and forage crops, the yields of these crops are significantly affected by salinity. Farmers continue to cultivate these crops because of the reluctance for alternate crop options or policy implications; 3- high saline (partially, sodic and heavy clay saline soils) at 8-12 dS/m as was observed during the plant growth season at the Akdepe Experimental site, Dashauz province (Turkmenistan) and at the Experimental Station of Priaralie Research Institute of Agroecology and Agrochemistry, Kyzyl-Orda (Kazakhstan). Farmers usually obtain very low yields of the crops and sometimes there are complete crop failures depending upon the severity of the problem. The potential area and experimental trials for cultivation of sorghum under saline environments of Central Asia are shown in Figure 1.

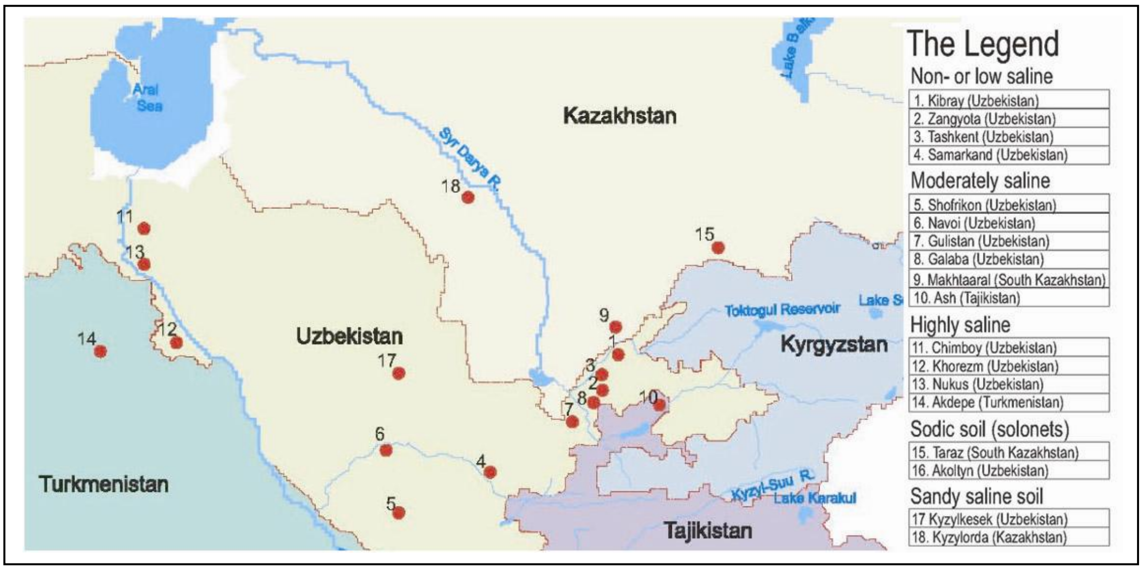

Fig. 1 Benchmark sites of sorghum and pearl millet production
Source: Kristina Toderich & Oksana Tsoy, 2007 (unpublished data)

Under farming saline environments of Central Asia the average values of green fodder production in the top-yielding sorghum varieties/lines varied from 97.0–113 t/ha with equivalent dry matter production levels ranging from 16.0–27.0 t/ha. Similarly, the top-yielding populations/lines of sorghum were identified that exhibited grain yield of local variety at 2.0–2.5 times. Preliminarily data revealed that plant productive longevity significantly varies among tested accessions and is positively correlated with the sum of effective temperatures. Sugar Graze, Speed Feed, Pioneer 858, and ICSV 745, SP 39105 sorghum varieties are considered to be the most early-maturation accessions. According to flowering patterns of sorghum introductions the following early-flowering genotypes were identified: SP 3905, Pioneer 858, ICSV 745, Speed Feed, Sugar Graze, Super Dan; and late-flowering samples: SP 39262, ICSV 745, ICSV 682. The high performing 8 accessions of sorghum with an average dry matter production of 13.3–27.3 t/ha and seed yield of 02.6–0.50 t/ha tested under different seasonal ranges of soil salinity could be also selected for further dissemination in Uzbekistan. The highest yield of fresh biomass varied between 7.0 kg/m^2 (Super Dan), 7.4 kg/m^2 (Speed Feed) up to 8.0 kg/m^2 (Sugar Graze) and 4.6 kg/m^2 (Pioneer 858), respectively. The majority of slow-growing and late-maturing accessions of sorghum, namely ICSV 112, SP 39105, SP 712 are characterized by having a thick succulent stems and long and ramified panicles that made these varieties useful both for forage (silage) and grain production.

Sweet-stalk local breeds and ICBA introduced genotypes/improved lines of Sorghum germplasm could be a potential raw and cheap material for the ethanol production. Cultivation of sorghum as it was determined by our investigation is economical in rainfed areas. In Central Asia sweet sorghum under arid/semiarid environments can be grown throughout 8–10 months of the year, with minimum irrigation requirements. Accumulation of fresh biomass positively correlated with height of plants and increased with the application of irrigation and fertilizer. The optimal fertilizers dosage of 120 kg nitrogen/ha and 60 kgP_2O_5/ha is suggested for increasing the sweet-stalk sorghum yield. At the Zangiota farm, Tashkent region 22 sweet sorghum genotypes and varieties were evaluated for fresh biomass, juice (total yield and extractable percent), as well total sugar production (Table 2.).

Table 2 Evaluation of introduced and local sweet sorghum germplasm

Zangiota Experimental Site, Tashkent region (Uzbekistan)

Improved lines/varieties	Height of plant. (cm)	Days at 100% milky stage	Yield t/ha		Juice		Sugar content of juice (%)	Total sugar (t/ha)
			Fresh biomass (t/ha)	Dry biomass (t/ha)	Yields (t/ha)	Extract %		
Uzbekistan St.	310	115	69.6	2.24	74.2	68.1	18.1	8.4
Safar 1	196	118	39.9	9.18	30.72	76.2	5.7	1.7
Safar 2	220	113	56.21	12.22	43.99	78.1	13.2	5.7
Safar 3	241	89	70.27	20.3	49.97	71.1	10.5	5.2
Sorghum yellow	184	105	23.32	5.18	18.14	77.7	15.1	2.7
Voljskoe 5	195	70	23.64	8.87	14.77	62.4	12.2	1.8
Orange 160	274	90	37.3	13.5	2.38	63.1	17.5	4.1
Karakalpakskiy	237	81	66.44	28.05	38.39	57.7	17.3	6.5
SP 39269	191	86	22.6	8.87	14.77	62.4	12.2	1.8
Speed Feed	200	118	70.3	1.82	5.21	74.1	11.7	0.7
Pioneer 858	180	88	14.0	4.06	9.44	71.3	10.3	1.0
Super DAN	233	110	25.23	7.06	18.17	72.5	9.4	1.6
Tashkenskiy belozerniy	280	113	38.2	24.84	13.36	34.9	6.7	0.9
Karlik Uzbekistana	150	127	30.02	18.94	11.08	63.1	12.2	1.3
Uzbekistan 5	222	83	37.05	15.56	21.49	58.4	11.6	2.5
Sugar Graze	234	120	62.9	11.89	33.21	65.2	15.4	5.9
ICSV 112	179	88	45.04	14.41	30.67	68.1	12.5	4.6
ICSV 745	170	116	57.49	24.82	32.67	56.8	15.3	5.0
IP 47529	174	128	34.5	22.04	12.46	36.1	13.7	1.7
ICSV 172	120	123	25.65	4.96	11.69	74.6	16.9	1.9
SP 39105	167	125	14.6	3.29	11.31	77.4	16.3	1.8
SP 47105	183	88	22.6	5.92	16.68	73.8	14.2	2.3

Sugar juice content and total sugar calculated on hectare ranges between 5.7-13.1% and 1.8-8.4 t/ha respectively. The highest yield of fresh biomass with produced about 68% of juice and almost 8.5 t/ha total sugar was marked for Uzbekistan variety, followed by Karakaloakskiy (6.5 t/ha total sugar) Orangevoe 160 (4.1 t/ha total sugar) as local varieties and Sugar Graze, ICSV 745, ICSV 112 among tested improved lines from ICBA that could successfully used for the ethanol production. The disadvantages of local varieties however are its continuous and late maturity. ISCV 112 and ISCV 745 varieties from ICBA sound more promising because of its almost simultaneous maturity, despite of insignificantly lowest extractable juice and total sugar production compared with standard.

As is seen in Table 2 most of the sweet sorghum improved lines/varieties get full milky stage between 81–128 days under two seasonal irrigation with a rate norm of 700–800 m^3 and a plant density of 80–82 thousand/ha. Stalk for sugar extraction can be harvested in 4–5 weeks before seed maturation.

Sorghum varieties Uzbekistan, Safar 1, Safar 2, Safar 3 bred at NARS (National Agriculture Research Stations) and some ICBA genotypes have yielding ability of 39.9-70.3 t/ha with an average 65.1–77.7 % extractable juice (Fig. 2).

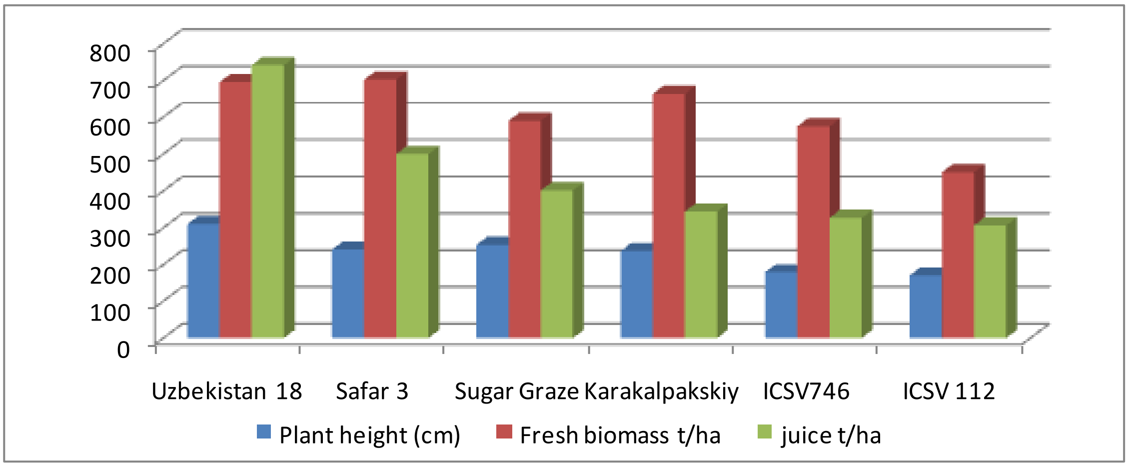

Fig. 2 Plant height, stalk yield and juice values of sweet-sorghum

Top sweet–sorghum varieties/improved lines harvested 80–115 days after planting.

Pilot production studies are encouraging and indicate cost effectiveness of up-scaling of grain and sweet sorghum raw material for ethanol production in Central Asian region. Although sorghum production is still low and gives in less value comparative to rice, maize, the crop is drought/salt tolerant and has good adaptability to grow on marginal lands. These traits give benefit and supplement fodder resources to the poor farmers in remote desert areas of Central Asia. Sweet sorghum varieties indicated in this paper are the most attractive for alternative uses of sorghum as bioethanol source. Future programs will bring new salt affected marginal lands into production of sorghum. However, state support, strong research and coordination between processing small/large companies, research institutions and farmers should be developed for sorghum breeding, adoption of relevant technologies available for the process of ethanol production.

Livestock wastes utilization and management in Uzbekistan

Livestock husbandry is a key industry in the economy of Uzbekistan and is represented mostly by karakul sheep, goats, camels, horses and other animals (more than 9,0 million heads), which inhabit large desert-grazing pastures that provide funds for the republic as meat at 20 %, milk at 10 %, wool at 40 %, sheepskin, wool at 35,0 %, and karakul pelts at 100%. Large horned cattle (more than 80%) is vastly developed in the areas of intensive irrigated lands of river valley, mountainous/foothill regions and only partially in the desert areas. Livestock production is mostly concentrated in cooperative farms or in the private sector. State sector plays an insignificant role. Private households now hold between one third and 80 percent of camels, cows, sheep and goats. Livestock wastes are produced almost exclusively from karakul sheep, horse, poultry and cow-calf enterprises on arid/semiarid pasture and range systems; a substantial portion of is still accomplished on pasture; most dairy farms utilize pasture when seasonal conditions permit; and karakul sheep and goat production is mainly a range and pasture operation. Grazing animals deposit manure directly on the land in pasture management systems and most of manure is spread by the animals. Though a pasture may be relatively large, manure may become concentrated near feeding and watering area often near flowing streams, these areas can quickly become barren of plant cover, increasing the possibility of contaminated runoff. Cattle watering are a common practice in basin streams. Livestock is heavily concentrated within the basin. During summer, cattle spend much time near or in streams, which results in increased organic and bacterial loads, bank erosion, turbidity, trampling of the riparian corridor, and locally-high concentrations of algae. Though not a basin-wide problem, livestock activity has decreased the quality of some local habitat. However, very little research done under farm conditions is available to determine whether or not water is involved in animal and human health problems.

In Uzbekistan the integration of crops and livestock, and the use of manure as fertilizer, are traditional practices and is the basis of the farming systems, especially at smallholder level. As is the case in other largely smallholder systems, livestock have a range of simultaneous roles in this system, including animal traction, production of manure and use as a cash reserve, in addition to the production of meat and milk.

Nowadays local farmers prefer to use traditional and low-cost technologies for recycling the livestock manure through:

- Anaerobic biodigestion (biodigesters)
- Aerobic biodigestion (composting)
- Direct application as organic fertilizer

The livestock waste treatment technique, however, are still too simple and improving is going insignificant. The monitoring system of manure composition, or its allocation to the drop fields is not completely developed. Farmers generally use manual labor for spreading of livestock manure on the surface of cropping lands. Such procedure is preferably to be done twice per year at the end of vegetation or in the early spring before crops cultivation. Livestock producers who follow current available technology in designing and managing of livestock waste have not adequate storage capacity for feedlot runoff and manure to permit timely disposal on the land; and/or adequate equipment and land for manure disposal. Usually large amounts of manure in open feedlots are deposited and accumulated in a relatively small area near the farming lands or on edges of rivers and channels dry banks (Figs.3, 4). Each manure field mounds/hills has a height of 0.5-1.5 m and 0.3-0.5 m in length. Mounds increase the surface area of the lot and reduce the chances of standing water. A mud and erosion problem is minimized by settling of man-made construction that is seen on figure 2 placed between the feedlot and filter ground earth channels to remove 60-75 percent of the manure solids. By this means water with dissolved solid manure flows by its own accord (flooding control) into the furrow/grooved (network of open ground canal) irrigation system that is one of historically oldest irrigation technology used in large scale in Uzbekistan. Removing solid waste helps reduce odors from holding mounds or ponds and allows easy removal of the waste water by irrigation.

Fig.3 Open-feedlots for livestock manure storage

Fig.4 Settling construction for semi-liquid manure removal into the irrigated drylands

Biodegradable waste is collected separately to produce environment friendly compost to make organic fertilizers that are sold to local farmers for direct application in or on soils for crop farming. Livestock producers or local pastoralists operate own small open-ground composting fabric, where very poor infrastructure and weak regulations are used. Piles of partly decomposed manure usually are not removed from earthen feedlots. No care is taken to avoid disturbing the mounds of compacted manure near the soil surface or open water streams. Thus, removal of the manure pack at the soil surface can allow nitrate movement into ground water.

The makhallahs or tribal leadership council's local residents are unaware of the land's toxicity, often grazing their livestock on the pastures.

In addition industrial production brings in large quantities of nutrients in the form of concentrate feed which can create enormous serious land and groundwater pollution problems because the resultant manure is often disposed of on nearby land or dry banks of river/canals stream. Livestock grazing in addition has been found to negatively affect water quality, hydrology, riparian zone soils wildlife (Soldatova, personal observations). We also noted that poorly managed livestock grazing could be a major cause of degraded floodplain areas in the whole Zerafshan river valley. As results native perennial grasses were virtually eliminated from vast areas, especially in the lower reaches and replaced by unpalatable or shallow–rooted vegetation less suited for holding soils in place. Also, trampling and grazing by cattle dramatically destroys riparian vegetation reducing the number and total biomass of shrubs and trees, which are crucial for shading streams, stabilizing stream banks and providing wildlife. It also affects air and biodiversity through the emission of animal waste, use of fossil fuels and substitution of animal genetic resources. This procedure is mostly common in remote desert areas, where the collection and processing of biogenic material is not sample-checked and examined for heavy metals and many other parameters (Toderich et al, 2004, 2006).

Fuelwood in the arid zones of Uzbekistan is often scarce as a result of deforestation and range degradation, leading to the ever-increasing role of animals as providers of manure for fuel, in addition to means of transport. Phasing out of energy subsidies has also caused that livestock manure, is not returned to the land, but used for heating and cooking, because alternative energy sources are no longer available or affordable. Local people convert cattle manure into "tappy" (the word describes wood in Uzbek), which they utilized as fuel for various domestic use. The technique of processing includes cleaning of livestock waste from straw, remains of plants, piles etc. and as is seen on Figs.5, 6, gradually drying on special open-earthenware walls for about two months.

Fig.5 Technique of drying and collection of cattle manure as fuel

Fig.6 domestic use of 'tappy' as organic fuel in desert areas

Implantation of biogas technologies in Uzbekistan, however, has good opportunities. The main sources of raw materials in the country, suitable for extracting biogas, are wastes of livestock-breeding and poultry farming, municipal solid wastes, food wastes, industrial organic wastes, municipal sewage and residues of crops. The most feasible source is wastes (manure) of stabling livestock-breeding industry. There are about 9500 large and medium scale farms in Uzbekistan (with livestock consisting of 6.7 mil. heads of cattle, 12.4 mil. heads of sheep, 83.6 mil. heads of swine and 21.1 mil. of poultry)._The biogas technologies, however, are not yet widely adopted in the country. The Government of the Republic of Uzbekistan and UNDP had launched a joint project "Assisting the Development of Biogas Technology in Uzbekistan", in 2005.

The following main impacts were considered:

- Potential of biogas utilization assessed and tested
- Increased productivity of farm greenhouses due to use of efficient organic fertilizers produced (liquid fraction of digested manure), natural gas saving and sale of high quality organic fertilizer produced (dry fraction - humus) on the local market;
- Improved heating of farm greenhouses and of additional farm facilities needs;
- Enhanced public awareness about biogas technology applications and/or benefits for the needs of rural population

First demonstration biogas plant has been placed into operation in "Milk-Agro" farm of Zangiota district, in Dec.2006. Volume of biodigesters is 120 m^3; gasholder's capacity is 60 m^3. The plant produces 300 m^3 of biogas and 10 tons of liquid organic fertilizer daily. The biogas is used as fuel for forage preparation, for heating the facilities of the farm and greenhouse, for generation of electricity for lighting and mechanized milking. Obtained high-quality organic fertilizer is applied on 279 hectares of sown area, to substitute chemical fertilizers that we used before for growing wheat, corn, and alfalfa. The greater part of the fertilizer is sold to other farmers.

The technical potential for biogas and organic fertilizer is assessed. The annual technical potential for biogas production from wastes of livestock-breeding, municipal solid wastes and other organic wastes is estimated as 8.9 million m^3. Besides, mastering this potential can secure agricultural sector of the country with more than 14 mil.tons of environmentally friendly and high-effective organic fertilizer per year.

As a result of this UNDP project implementation, the farm obtained the biogas-plant built up by the requirements of modern technologies.

Its capacity permits to generate 300 m^3 of biogas and 10 tons of liquid bio-fertilizer per day. With installation of the plant, the stock farm has got biogas to be used as a quality fuel for gas-stoves of dining-room and inhabitants of adjacent houses, for housing and greenhouses heating, for generating electricity for lighting and energy supply of milking machines. In addition, the biogas-plant produces environmentally safe and highly effective bio-fertilizer (in substitution to the chemical analogues), the part of which, at the present time, is applied for growing wheat, maize and alfalfa on the area of more 279 hectares. The other part is marketed to consumers. The annual volume of revenue of the farm, gained thanks to the biogas-plant, will amount to more than 100 million Uzbek sums with net annual income of 59 million Uzbek sums by the end of the year. As it was fairly noted by the manager of "Milk Agro" farm Mr. Yuldashev Ravshan, by means of production application of the biogas-plant, the farm has obtained not just an additional source of revenue, but chiefly it could achieve improvement of sanitation condition in the territory of the farm, dining-room as well as at houses of biogas consumers. It is reasonable to point out that the use of biogas has released prospective opportunities of its application in other technological schemes. In a condensed form, biogas can be used as fuel for agriculture machineries that would allow saving up to 10 million Uzbek sums annually due to the cost cut resulted from avoiding the consumption of traditional types of fuel. On the base of the plant, it is intended to arrange the production of bio-fodders and use them as supplement to other fodders that would further the calves' growth, gain in weight and milk yield. Besides economic, there are social benefits: we have created five new job places and hired young men, who previously had no permanent work place. The processing of manure in the biogas-plant would contribute to the reduction of methane emission (in terms of CO_2) to the atmosphere by more than 1,200 tons per annum (Table 3).

Table 3 Potentials of biogas, biofertilizers and CO_2 decreasing

	Potential of biogas production (mln/m^3)		Potential of production of Bio-fertilizers (thousand ton)				Potential of decreasing of emission of CO_2 (thousand ton)	
			Liquid		Dry			
	Gross output	Technical output	Gross output	Technical output	Gross output	Technical output	Gross output	Technical output
Total in Uzbekistan								
Yearly	8700.0	4274.3	246800.0	90700.0	38500.0	14320.0	95342.9	47600.8
Daily	24.9	12.2	700.0	265.3	109.4	40.74		
Tashkent region								
Yearly	700.0	269.8	15015.0	1540.0	2252.3	231.0	7671.2	2956.7
Daily	2.0	1.06	42.9	4.4	6.4	0.66		
«Milk Agro» Farm								
Yearly	0.63	0.63/**0.11***	14.0	14.0/**4.2***	2.1	2.1/**0.63***	7.6	7.6/**1.2***
Daily	0.0018	0.0018/ **0.0003***	0. 04	0.04/ **0.012***	0.006	0.006/ **0.0018***		

During the project implementation, the significant attention was paid to the problems of public awareness in the field of biogas technologies application. To this end, the project participated at the International Exhibition "Clean energy. Energy saving" that took place in Tashkent in March 2007. There were arranged special posters with information, photo pictures, biogas-plant installation diagram created within the project frame at the "Milk Agro" farm.

The visitors, who interested in the plant operation, were provided with the relevant explanation and printed pamphlets on perspectives of biogas technologies in Uzbekistan. Also, for those who wished, during the three days of the exhibition, there were arranged field trips on demonstration of the biogas-plant functioning. The all visitors, particularly the government officials, farmers, private entrepreneurs, teachers, university and high school students, expressed their great interest in the stand of the biogas-plant.

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