Technical Assistance to the Zimbabwe Agricultural Growth Programme

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Short-term assignment on

Development of implementation and impact tracking plans for services, grants and trainings related to green technologies

(FINAL DRAFT)

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Abbreviations and Acronyms

AAHMC	Anchor Animal Health Management Centre
BEST	Beef Enterprise Strengthening and Transformation
BVC	Beef Value Chain
CBC	Cattle Business Centre
DACE	District Agricultural Centre of Excellence
DVS	Department of Veterinary Services
EUD	European Union Delegation
FAO	Food and Agricultural Organisation of the United Nations
GIC	Goat Improvement Centre
GoZ	Government of Zimbabwe
GPBA	Goat Producers Business Association
GVC	Goat Value Chain
ISALS	Internal Savings and Lending Scheme
IPVC	Inclusive Poultry Value Chain
LIMS	Livestock Information Management System
LMAC	Livestock and Meat Advisory Council
MFI	Micro Finance Institution
MGF	Matching Grant Facility
MoU	Memorandum of Understanding
NAPF	National Agricultural Policy Framework
NDS1	National Development Strategy 1
PBA	Poultry Business Association
PIB	Pig Industry Board
PIMS	Poultry Information Management System
PPP	Public-Private Partnership
PPBS	Pork Production Business Syndicates
PSP	Private Sector Players
PVC	Pork Value Chain
SAFE	Transforming Zimbabwe's Animal Health and Sanitary and Phytosanitary / Food Safety Systems for the Future
SAT	Sustainable Agriculture Technology
StM	Small to Medium
TranZDVC	Transforming Zimbabwe's Dairy Value Chain for the Future
VALUE	Value Chain Alliance for Livestock Upgrading and Empowerment
WHH	Welthungerhilfe
WVI	World Vision International
WVZ	World Vision Zimbabwe
ZADT	Zimbabwe Agricultural Development Trust
ZAGP	Zimbabwe Agricultural Growth Programme
ZAKIS	Zimbabwe Agricultural Knowledge and Innovation Services
ZDIT	Zimbabwe Dairy Industry Trust
ZFU	Zimbabwe Farmers Union

EXECUTIVE SUMMARY

The Zimbabwe Agricultural Growth Programme 2016 – 2023 (ZAGP) goal is "contributing to the development of a diversified and efficient agricultural sector that promotes inclusive **green economic growth**". It's six livestock focused projects, namely (i) Beef Enterprise Strengthening and Transformation (BEST) (ii) Inclusive Poultry Value Chain (IPVC) (iii) Transforming Zimbabwe's Animal Health and Sanitary and Phytosanitary/Food Safety Systems for the Future (SAFE) (iv) Transforming Zimbabwe's Dairy Value Chain for the Future (TranZ-DVC) (v) Value Chain Alliance for Livestock Upgrading and Empowerment (VALUE) and, (vi) Zimbabwe Agricultural Knowledge and Innovation Services (ZAKIS) have green technology activities among their interventions. The development and implementation of green technologies by the projects is consistent with the national development agenda and thrust that supports inclusive and sustainable green economic growth as enunciated in key policy and plan documents including the National Development Strategy 2021 – 2025 and the National Agricultural Policy Framework 2018 - 2030.

In view of the green economic growth premise of the programme goal and centrality of green technologies in ZAGP project interventions, this assignment was commissioned with an overall objective of "*development of implementation and impact tracking plans for services, grants and trainings related to green technologies*" with four specific objectives as captured in Text Box 1. The exercise involved literature review, consultations with the six projects' officials, visits to 15 green technology sites, discussions with Government extension officials and farmers during site visits, data collation and analysis, report drafting and a validation meeting of projects' officials. The information in this report relates to the time of the fieldwork, July and August 2021.

Text Box 1

The specific objectives of the assignment are:

1. *A complete listing, project by project, of all the green technology services, grants and trainings that have been implemented and are being developed under ZAGP projects,*

2. *Analysing existing implementation plans for these services, grants and trainings, estimating the potential impact of what has been implemented to date and recommending changes to be made to the way they are implemented,*

3. *Reviewing the green technology impact tracking mechanism with each project individually, and suggesting changes where necessary, and*

4. *Write ups to explain the implementation and impact tracking systems agreed with the projects*

The six projects are spending between 1.70% and 5.5% of their budgets on hardware type green technologies which this exercise has focussed on. If the broad definition of the term technology, which refers to the application of scientific knowledge for practical purposes of solving problems or achieving goals especially in industry, had been used then all activities including technical solutions that help preserve the environment and improve agricultural, especially livestock, production and productivity, would have been considered green. This would have entailed looking at almost three quarters of ZAGP projects' activities.

Eight hardware type green technologies are being implemented across the six ZAGP projects as summarised in Text Box 2, overleaf. While the technical aspects of a green technology, i.e. design and operation, remain the same irrespective of implementing project, the mode of delivery in terms of services, grants and trainings differ among the projects. For the services, all projects are involved in procurement and installation. The extent of involvement varies depending on the installation requirements. Green techs that are capital intensive like solar powered incubators, tubular bio-digesters and solar power system for lighting and cooling have more project input in procurement and installation. Some of these also involve bulk procurement or entering agreement with a contractor to supply and fix at many sites. The less capital intense, e.g. dome bio-digesters, have less project involvement in procurement and establishment. Indications are that farmers are happy with projects

involvement in procurement and installations. However, some concerns were expressed on delays in procurement, e.g. by Rusitu dairy farmers, farmers preferring larger solar power units to power wider ranges of enterprise activities and speedy address of functionality issues relating to some solar powered incubators.

Text Box 2 Green technologies being implemented by ZAGP projects

Green technology	Projects implementing the technology
Bio-digesters (a)Tubular and (b) Dome	BEST, IPVC, VALUE and TranZ-DVC
Rocket stove	IPVC
Solar powered incubators	IPVC
Saw dust pelleting plant	IPVC
Solar power systems for lighting (Photovoltaic) & cooling	IPVC, TranZ-DVC, VALUE and ZAKIS
Solar power systems for: a) CBCs – powering lights, internet, computers, & drugs & vaccines cold chain storage. b) Admin. blocks - lights, computers, lab equipment, internet, etc.	BEST, TranZ-DVC, SAFE and, ZAKIS
Solar powered water systems (including boreholes, wells and sand abstractions).	BEST, IPVC, TranZ-DVC, VALUE and ZAKIS
Battery powered tricycles	IPVC and TranZ-DVC

Grants are disbursed differently by the projects. Grants to institutions such as Chibero College of Agriculture and Matopos Research Institute by ZAKIS and IPVC are 100% cost of the green tech. SAFE also provides 100% cost of the green technology at Anchor Animal Health Management Centres. The AAHMCs are Department of Veterinary Services (DVS) property and therefore a public good. Similarly, BEST and VALUE provide 100% of costs of installation of green tech at Cattle Business Centres (CBCs) and Goat Improvement Centres (GICs) which centres are also a public good. VALUE and TranZ-DVC are operating Matching Grant Facilities (MGFs) whereby project pays 70% and the farmer 30% of the green tech cost. MGFs are positively considered by farmers as they enable limited resources reach more beneficiaries, instil commitment and sense of ownership of assets and reduce donor dependency. Farmers met in Lupane, Chivu and Chipinge districts favourably compared MGFs with SNV's matching grants for bio-digesters in 2014 which are still well maintained and functional in the districts. IPVC pays the full cost of green tech asset with the farmer paying an equivalent of 10% of the grant to his/her Poultry Business Association (PBA) to "*support the organisation evolve into a big and viable business entity*" *(Goromonzi PBA chairman)* There is neither a defined timeline nor a mechanism for enforcing the 10% payment. These are issues that IPVC needs to address.

The MGF approach, with an increased project to farmer ratio of 50:50, should be considered by all projects for future delivery of tried and tested green technologies such as solar power systems and bio-digesters to farmers for private good assets. However, there should be exception when a technology is being tested, like the rocket stove, or being given to institutions or centres to be a public good for which 100% grant should be considered as at present. In any case the communities at centres such as CBCs and GICs do provide local resources and labour in construction of the infrastructure housing the green technology.

Training on green technology is mostly provided by contractors who install the green assets. The farmers or focal persons, in the case of AAHMCs, CBCs, GICs, ACEs and DACEs, are trained on the operation and also given user manuals. Farmers also consider involvement in the installation of, for example, bio-digesters as hands on training. Other training has been in the form of look and learn visits which unfortunately have been curtailed by the Covid19 travel restrictions. Some projects, e.g. TranZ-DVC, trained farmers on smart climate dairy farming practises including use of renewable energy.

The six projects are currently monitoring and reporting on performance against targets of activities including implementation of green technologies. IPVC has invested most in

studying different green technologies, tracking implementation including a scoping study done jointly with the University of Genoa and developing a green tech check list seeking information on use, effectiveness, efficiency, economics and environment. TranZ-DVC did a baseline in 2019 which, inter-alia, looked at renewable energy use and has a dashboard that tracks progress of implementation of activities including green techs. VALUE has a template for green techs which serves as a dashboard for implementation progress. The reporting by projects is at output level. All the projects appreciate the need to go beyond this level to outcomes and impact. Impact may be realised or manifest long after the project period.

Given the long term nature of impact manifestation, this assignment could only infer on potential impact of green tech implemented by the projects. In order to make the inferences the assignment looked at outcomes, realised or possible, to get pointers on likely impact. Discussions at project sites informed a matrix of outcomes and potential impact of the green technologies. Indications are that outcomes include increased knowledge of environmental issues and climate change, increased adoption of green tech with farming business/ economic, social and environmental benefits. The expected impacts from these are improvements in livelihoods and wellbeing, environmental conservation, social cohesion and confidence and positive self-esteem in women.

A framework for tracking green technologies implementation progress and impact is proposed. It is predicated on collection of information on variables giving pointers to outcomes and impact, which are: types of green technologies being implemented; farmers/households benefitting; animals, by type benefiting; functionality and effectiveness of green technologies; uptake by new producers, integrators, processors, satellite CBCs, etc; changes technology brings to households and community; return on investment; how environment is benefitting; and testimonies and case studies on how green technologies are making a difference. A different set of variables is proposed for ZAKIS focusing on contribution to financial stability and sustainability of the ACEs and DACEs.

In view of that (i) ZAGP projects will be conducting end line evaluations (ii) IPVC has a green technology evaluation lined up, and (iii) other projects have no budgets for standalone green technologies evaluations, it is proposed that:

a) ZAGP projects include sections on green tech outcomes and impact assessment in end of project evaluations addressing the variables outlined above,
b) IPVC's standalone green technologies outcomes and impact assessment ensure that all variables outlined above have been addressed in the terms of reference, and
c) TA-ZAGP commissions a meta-analysis exercise premised on results of the different projects evaluations, (a) and (b), thereby enabling the comparing and contrasting of outcomes and impacts of green technologies across the six projects. The exercise is to be done when all the six projects have done their end of project evaluations.

For green tech impact tracking from present and beyond projects period, it is proposed the enterprise structures BEST, IPVC, SAFE and VALUE are establishing/strengthening be responsible for gathering information on a quarterly bases and feeding into the Livestock Information Management System (LIMS) platform of DVS. LIMS is being developed with support from SAFE. TranZ-DVC is developing a Digital Data Gathering System nested in Zimbabwe Dairy Industry Trust. The dairy enterprise structures will feed information on a quarterly basis into this system. For ZAKIS, it is proposed the ACEs and DACEs include sections on green tech in their reports to the Departments of Agricultural Education and Farmer Training and Research and Specialist Services of the Ministry of Lands, Agriculture, Fisheries and Rural Resettlement. The variables on which information is to be regularly collected and reported have been outlined project by project and are in line with those in the aforementioned framework.

1.0 OBJECTIVE, PURPOSE AND EXPECTED RESULTS OF THE ASSIGNMENT

1.1 Overall Objective of the assignment

The Zimbabwe Agricultural Growth Programme (2016 – 2023) is a EUR40 million joint programme of the Government of Zimbabwe and EUD whose goal is "contributing to the development of a diversified and efficient agricultural sector that promotes inclusive **green economic growth**". The programme is being implemented by consortium of organisations in partnership with relevant Government Departments and private sector players. The programme consists of six livestock focused projects, namely (i) Beef Enterprise Strengthening and Transformation (BEST) (ii) Inclusive Poultry Value Chain (IPVC) (iii) Transforming Zimbabwe's Animal Health and Sanitary and Phytosanitary/Food Safety Systems for the Future (SAFE) (iv) Transforming Zimbabwe's Dairy Value Chain for the Future (TranZ-DVC) (v) Value Chain Alliance for Livestock Upgrading and Empowerment (VALUE) and, (vi) Zimbabwe Agricultural Knowledge and Innovation Services (ZAKIS). In view of the green economic growth premise of the programme goal, green technologies are an essential element of all interventions by ZAPG projects. To this end, this assignment has been commissioned with an overall objective of the "**development of implementation and impact tracking plans for services, grants and trainings related to green technologies"** under the ZAGP projects[1].

1.2 Purpose of the assignment

The six projects under ZAGP are developing and implementing green technologies as part of strategies on transforming the Zimbabwe agricultural sector and contribution to achievement of an **inclusive and sustainable green economy**. These green technologies are being implemented as parts of pilot initiatives by projects with a view of scaling up within and beyond project target groups and geographic and sub-sectoral areas. The scaling up will be through agricultural producers and processors adopting and adapting the green technologies to their enterprises. Given the pilot nature of the initiatives, it is therefore imperative for ZAGP to take stock of the green technologies being developed and implemented by its six projects, their potential impact and the impact tracking mechanisms that are in place. Through the stock take, lessons can be drawn and suggestions for improvement made where necessary. Text Box 1.2 gives the specific objectives of this ZAGP green technologies taking stock assignment.

Text Box 1.2

The specific objectives of the assignment are:

1. *A complete listing, project by project, of all the green technology services, grants and trainings that have been implemented and are being developed under ZAGP projects,*

2. *Analysing existing implementation plans for these services, grants and trainings, estimating the potential impact of what has been implemented to date and recommending changes to be made to the way they are implemented,*

3. *Reviewing the green technology impact tracking mechanism with each project individually, and suggesting changes where necessary, and*

4. *Write ups to explain the implementation and impact tracking systems agreed with the projects*

Source: Assignment ToR.

1.3 ZAGP green technologies' fit in national context

The development and implementation of green technologies by ZAGP projects is in line with the Government of Zimbabwe's (GoZ) development agenda and thrust as enunciated in key policy and plans documents. The National Development Strategy 2021 – 2025 (NDS1) recognises that environmental protection, climate resilience and natural resources

[1] ZAGP green technologies assignment Terms of Reference (ToR).

management are key enablers for the attainment of Vision 2030 and the Sustainable Development Goals (SDGs). Accordingly, NDS1 proposes strategies that include: promoting sustainable production and consumption; promoting climate smart innovations and technology transfer; strengthening capacity building and awareness on climate change adaptation and mitigation; promoting the reduction of greenhouse gases and alternative energy solutions; promoting low emissions development pathways; and strengthening research and technology development.

The National Agricultural Policy Framework 2018 - 2030 (NAPF) has "**sustainable (green) agriculture**" as one of its main pillars. The Framework notes that Zimbabwe is experiencing climate change and energy challenges, among other issues affecting agricultural production and productivity. The NAPF further notes that the country's abundant renewable resources for sustainable energy production are barely exploited despite these challenges and that there is high potential to invest in renewable energy such as bio-digesters, mini-hydro, solar energy, solar water heaters, bio-ethanol and biodiesel as an essential development strategy to stabilise access and reduce costs in energy access. Development and implementation of green technologies by ZAGP projects is, therefore, consistent with the national development agenda and thrust that supports inclusive and sustainable green economic growth and development.

1.4 Background to the assignment

1.4.1 How the exercise was conducted

A virtual inception meeting, to clarify and elaborate the terms of reference and expectations, with the TA-ZAGP team leader kick-started the exercise. This was followed by literature review covering ZAGP projects documents and reports and other independent literature on green technologies. The literature review culminated in a work plan and a data collection matrix that would guide the field work. Virtual meetings were conducted with representatives of the six ZAGP projects, BEST, IPVC, SAFE, TranZ-DVC, VALUE and ZAKIS, to gather more information and views on the green technologies being implemented and additional project reports. The consultative meetings were also used to agree on samples of green technology sites to be visited for the exercise. Consultations were continued through the course of the exercise for clarifications, additional information and more views. Covid19 protocols and regulations including face masking, social distancing and sanitisation, were observed during all project sites visits, in July and August 2021, to protect farmers, ZAGP projects and Government personnel and the consultant. People met during the sites visits were asked and they agreed to have photos taken and to be quoted in the report. Lists of documents reviewed, green technologies sites visited and people consulted during the exercise are given at the end of this report as Annexes 1, 2 and 3, respectively. A draft report was produced and shared with projects for feedback which informed a revision. A validation Skype meeting of projects' officials was conducted on 20 January 2022. All the information in this report relates to the time of the fieldwork, July and August 2021.

1.4.2 Specific focus of the assignment – green technology defined for assignment

ZAGP projects literature review and consultations with projects personnel revealed that the programme is contributing to a green economy in many ways that include technical solutions that help (a) preserve the environment as value is unlocked from it through various livestock production activities, and (b) improve agricultural, especially livestock, production and productivity. Environmental protection measures such as appropriate composting of goat and pig manure for homestead soil fertility improvement so as to save on manufactured fertilizers, planting supplementary forage trees and drought-tolerant small grains and

cassava as feed stock and introduction of improved genetics under VALUE project contribute to green economy. Similarly, on farm feed formulations under the IPVC and TranZ-DVC projects and leguminous fodder plots combined with crop rotation strategies and better breeds programme under BEST and VALUE can be considered green technologies in the sense of the broad definition of the term technology which refers to **the application of scientific knowledge for practical purposes of solving problems or achieving goals especially in industry**[2]. If all innovative, environmental friendly and climate smart techniques as well as other best practices that promote livestock production and productivity were to be considered as green technologies, then this assignment would be looking at almost three quarters or more of the ZAGP projects' activities. In order to focus this assignment the term green technologies is used to refer to the **hardware type technologies** such as bio-digesters, solar energy systems, machinery and equipment for smart agriculture, etc. Brief descriptions, accompanied by images, of the different hardware type green technologies being implemented by ZAGP projects are given in Annex 4 at the end of report.

2.0 GREEN TECHNOLOGIES BEING DEVELOPED AND IMPLEMENTED BY ZAGP PROJECTS

The terms of reference require "A complete listing, project by project, of all the green technology services, grants and trainings that have been implemented and are being developed under ZAGP projects".

The six ZAGP projects are developing and implementing a wide range of hardware type green technologies on pilot basis. These include: solar energy systems for lighting, heating, incubation and refrigeration; bio-digesters for energy for heating and lighting; battery powered tricycles for transporting farm inputs and produce; and solar powered water pumping and conveyance systems for watering animals, irrigation of fodder crop plots and vegetable gardens. The different technologies are being implemented across the six projects with some projects, e.g. SAFE and ZAKIS focusing on one or two while others like IPVC and VALUE are piloting a wide spectrum of green technologies. Whilst the technical aspects, functioning and application of a green technology would be the same irrespective of the project implementing it, the services, grants and trainings supporting the implementation of the technology vary from ZAGP project to project. Sections 2.1 to 2.6 below provide full lists of green technologies being piloted by the ZAGP projects and the services, grants and training supporting the implementation.

2.1 Green technology services, grants and trainings by BEST project

ZAGP's BEST project, being implemented by a consortium comprising World Vision International (WVI), LMAC, WHH, SAT, Nurture Education Trust and ZADT, has an overall objective to contribute to the development of a strong, competitive Beef Value Chain (BVC) that promotes enhanced trade, employment creation, food security and **inclusive green economic growth**. Towards the green economy the project is demonstrating and promoting three hardware type green technologies, namely (a) solar power system for lighting, refrigeration and other office use like powering computers, printers and internet (b) solar powered boreholes, and (c) bio-digesters for heating, lighting and sustainable waste management, at the ten Cattle Business Centres (CBCs) that it is supporting in districts

[2] Definition of term technology adapted from definitions in various independent literature.

across the country. BEST's green technologies budget of €208,300 is 2.45% of total project budget of €8,488,009.

All green technologies installed to date were reported functional except for the solar water pumping system at Umguza CBC, which was removed owing to low water yield of the borehole. Table 2.1 lists the green technology services, grants and trainings implemented by the project. The project plans to demonstrate and promote creation of energy harvesting techniques (bio-digesters) and clean energy (solar) at all CBCs across the country.

Table 2.1 Green technology services, grants and trainings implemented by BEST

Green technology	Sites where green technologies have been implemented	Services provided	Grants provided	Training provided	Comment
1. Solar powered borehole	Dendere CBC – Kwekwe District Mutiusinazita – Buhera District Mateta CBC – Gokwe South District Mathombo CBC – Lupane District Mayo – Makoni District Lapache – Mwenezi District Dotiti CBC – Mt Darwin District Mahlanguleni – Chiredzi District Umguza CBC – Umguza District*	1. Competitive selection of contractors for siting, drilling and fitting of pump, solar panels, storage tanks and piping. 2. Supervision of installation.	Budget & disbursement per solar powered borehole system €11,864 Project covered 100% of green technology cost.	Training of CBC committee members on operation of the solar powered borehole water system by the contractor.	Community members supplied unskilled labour e.g. digging trenches for piping.
2. Solar power system (for office lighting & other office use)	Mutiusinazita CBC – Buhera District Muhlanguleni CBC – Chiredzi District	As above.	Budget & disbursement per solar system €6,000 Project covered 100% of green tech cost.	Training of CBC committee members and PSP staff on operating system by contractor.	User manual provided to CBC committees by contractor.
3. Bio- digester	Lupane District – Bio-digester installed at homestead of a female lead farmer for demonstration. Umguza District – Bi-digester installed at homestead of an elderly couple. Mwenezi – Bio-digester at lead farmer.	1. All purchased inputs. 2. Builder for the construction of bio-digester. 3. Supervision of installation.	Budget & disbursement per bio-digester €2,966 Project covered 100% of purchased inputs.	1. Farmer participated in construction of biogas plants. 2. Farmers trained in the operation of the biogas plant by BEST personnel.	Community supplied unskilled labour and local resources. Learning from participation in construction.

Notes:
Implementation situation as in August, 2021. It is important to note that sites where green technologies are implemented, services, grants and trainings provided have changed and continue to change upward as project implementation progresses.
***** Solar pump system at Umguza CBC later removed owing to low water yield of the borehole. Plan is to install the system at a nearby borehole serving the CBC.

2.2 Green technology services, grants and trainings by IPVC project

ZAGP's IPVC project is being implemented by COPSE in partnership with SAT, Cultivating New Frontiers in Agriculture (CNFA), LMAC and WWH. The project's overall objective is the development of an efficient poultry value chain which contributes to **inclusive green economic growth** of Zimbabwe. Towards the greening of economy, the project selected eight green technologies to power the poultry value chain. These technologies include photovoltaic lighting, PBA solar lighting, tubular and fixed dome bio-digesters, rocket stoves, solar powered incubators and battery powered tricycles and are being piloted in five geographic areas or clusters, namely Bulawayo, Gweru, Harare, Masvingo and Mutare where these are being implemented at lead farmers and selected entrepreneurs. The green technologies were selected on criteria of low environmental impact, replicability and return on investments within one to two year periods. A total of €133,346.93 has been given out as grants for green technologies out of a budget of €250,000 which represents 4.2% of total

project budget of €6 million. And €7,310.59 out of a budget of €57,500 has been spent on technical support for green technologies.

Table 2.2 Green technology services, grants and trainings implemented by IPVC

Green technology	Number implemented	Services provided	Grants provided	Training provided	Comment
Fixed dome bio-digesters	2	Project identified builders.	US$7,811 per unit	Farmers trained on use of green technology by contractor.	Heating brooders (charcoal is costing about US8/50kg bag).
Tubular bio-digesters	1	Project identified contractor.	US$6,167 per unit		
Rocket Stoves	1	Project identified and contracted supplier on supply and fix basis.	US$1,100	Farmer trained by supplier. Farmer adapted tech & also build a modified version.	Beneficiaries are lead farmers. Beneficiaries provided local labour and materials.
Photovoltaic lighting	8	As above.	US$4,937 per set	Farmers trained on use of green tech by contractor	3KVA system. Lighting for layers.
PBA solar lighting	5		US$2,850 per unit		3KVA PBA electrical systems
Saw dust pelleting plant.	0	-	-	-	Pellets for use in rocket stoves. Target is Mutare PBA
Solar powered incubators	19	Project identified and contracted supplier on supply and fix basis.	US$2,666 per set.	Farmers and focal persons at Matopos trained on how to operate the solar powered incubators by the contractor.	Hatching of dual purpose and indigenous chicks. Beneficiaries are lead farmer, farmer groups and PBAs. Farmers pay 10% of total cost to PBA. Matopos received 100% grant .
Battery powered tricycles / scooters	9	Procurement	US$1,250	Farmers trained on use of scooters by supplier.	For egg distribution and marketing. Beneficiaries are farmer groups.

Source: IPVC Presentation at TA-ZAGP Focused Coordinating Meeting, April 2021. It is important to note that the numbers of green technologies implemented and services, grants and trainings provided have since changed and continue to change upward as project implementation progresses.

2.3 Green technology services, grants and trainings by SAFE project

SAFE project is being implemented by a partnership of FAO as lead agency, Department of Veterinary Services (DVS) of the Ministry of Lands, Agriculture, Fisheries, Water and Rural Resettlement (MLAFWRR) and the Department of Environmental Health (DEH) of the Ministry of Health and Child Care (MoHCC). The project seeks to transform the country's animal health, sanitary and phytosanitary/food safety systems for improved livestock productivity, food safety and consumer safety to enhance market access. Among the hardware type green technologies being considered are solar power system at Anchor Animal Health Management Centres (AAHMCs). These systems would be for lighting, refrigeration for cold chains for vet medicines and vaccines and animal tissue samples and improved communication with respect to powering computers, printers and internet as well as for on-line transactions for veterinary supplies.

SAFE's budget for green technologies in general is 5.5% of total project budget of €4 million. First two pilot solar power systems have been established at Nyamizira AAHMC in Mayo, Makoni district and Nyava AAHMC in Bindura district, each with a budget of €7,140 (US$8,500). These two AAHMC are serving as learning points before roll out to the remaining proposed 24 AAHMCs. Each AAHMC is expected to serve about 30,000 cattle plus small livestock including sheep, pigs, goats and poultry. Most of the areas proposed for AAHMCs are not connected to the national power grid.

Table 2.3 Green technology services, grants and trainings implemented by SAFE

Green technology	Project sites where green technology has been implemented	Services provided	Grants provided	Training provided	Comment
Solar power systems at AAHMCs	a) Nyamizira AAHMC in Mayo, Makoni district b) Nyava AAHMC in Bindura district.	Selection of contractor through a competitive bidding process. Installation by contractor.	An amount of €8,500 reserved per solar power system installation per AAHMC and €14,300 (US$17,000) is being spent on the two pilots.	Contractor to provide training on operation of the solar power system to focal personnel of DVS and Private Sector Players (PSP) at the AAHMC.	These are work in progress at the two pilot AAHMCs.

Implementation situation as in August, 2021. It is important to note that sites where green technologies are implemented, services, grants and trainings provided continue to change upward as project implementation progresses.

2.4 Green technology services, grants and trainings by TranZ-DVC project

We Effect, in partnership with the Zimbabwe Association of Dairy Farmers (ZADF), Zimbabwe Farmers Union (ZFU) and Zimbabwe Dairy Industry Trust (ZDIT) is implementing the €6,999,610 TranZ-DVC project. The project aims to address the root causes of under-performance in the Dairy Value Chain (DVC) in Zimbabwe by strengthening the linkages between production, processing and financing. One of its activity areas is to promote climate smart dairy farming through the €2,849,580 Matching Grant Facility which deliberately emphasises purchase of climate smart productive assets like solar power systems and bio-digesters for lighting, heating, cooling/refrigeration and water pumping at production and processing levels. To date €1,240,429.45 has been used and €140,798.53 (being 2% of total project budget) of it on hard ware type green technologies. Table 2.4 below presents green technologies implemented by TranZ-DVC to date.

Table 2.4 Green technology services, grants and trainings implemented by TranZ-DVC

Green technology	Numbers of beneficiaries	Services provided	Grants provided	Training provided	Comment
Solar powered water pumping system at farm level	46 dairy farms	Green technology procurement services ... Project identifies suppliers of green technologies and enter MoUs with same for service provision to farmers and MCCs.	€90,031.18	a) Training on operation of green technologies given to farmers and/or focal persons at MCCs by contractors. b) 2,842 (1320 females and 1522 male) farmers trained on smart climate dairy farming practises including water harvesting, conservation farming, fodder and use of renewable energy. Training by We Effect.	The project also produced and distributed 250 climate smart agricultural study circle material in form of books. This contributes to farmer training in the pluralistic extension drive.
Solar powered milk cooling system at farm level	22 dairy farms		€17,870.88		
Bio- digesters at farm level	2 dairy farms		Farmers' match.		
Solar powered boreholes at MCC level	7 MCCs		€11,813.23		
Solar powered milk cooling systems at MCC level	6 MCCs		€21,083.24		
Solar power water heaters at MCC level	4 MCCs		Farmers' match		
Battery powered tricycles.	4 tricycles at Rusitu, Chipinge.		Nil		Tricycles donated by Mobility for Africa.

Source: TranZ-DVC PowerPoint Presentation at ZAGP Monthly Focus Meeting: Green Technology, April 2021. It is important to note that numbers of beneficiaries, services, grants and trainings provided continue to change upward as project implementation progresses.

The green technologies being implemented under TranZ-DVC are appreciated by dairy farmers and their Associations. The renewable energy thrust is considered key to improving the performance of the DVC. Energy costs contribute much to cost of milk production and

processing. The Nharira MCC in Chivu district, for example, reported cost of milk processing having fallen by almost 50% following switch from ZESA to solar power system for milk processing and borehole water pumping. The solar power system and solar powered borehole were funded by TranZ-DVC through MGF.

2.5 Green technology services, grants and trainings by VALUE project

ZAGP's VALUE project is being implemented by a consortium comprising ActionAid, COSV, and Mercy Corps. The project seeks to contribute to the development of an inclusive and diversified agricultural sector that promotes **inclusive green economic growth** and is targeting the pork value chain (PVC) and goat value chain (GVC). The project is supporting Goat Producers Business Associations (GPBA) and their 12 Goat Improvement Centres (GICs) in twelve districts in 5 provinces, Matebeleland North, Matebeleland South, Mashonaland East, Mashonaland Central and Manicaland. US$20K set aside for each GIC. Communities provide local materials and labour in the construction of GICs. It also supports Pork Production Business Syndicates (PPBSs) in Mashonaland West and East provinces.

Towards greening the economy and social inclusion, the project is awarding farmers smart subsidies for, among other activities, appropriate green technologies including biogas installation and solar energy for cold storage chains and water systems for watering goats and pigs and fodder gardens. A total of €125,454 (being 1.71% of total project budget of €7,340,596) is set aside for smart subsidies whereby project meets 70% of cost and farmers put in 30% in the form of labour and local materials. €66K of the smart subsidies budget has been disbursed to date. Maximum grant size is €5,400, average grant size €1,394 and total grant for smart subsidies €125,454 (VALUE Full Application Form, Annex A.2).

Table 2.5 Green technology services, grants and trainings implemented by VALUE

Green technology	Number implemented	Services provided	Grants provided	Training provided	Comment
Solar power systems at GICs for lighting, water pumping for watering goats & pastures irrigation.	12	Procurement and installation of solar power systems.	US$20,000 set aside per GIC for infrastructure and green tech.	GIC focal persons trained in use of the green tech by contractors.	GICs in 12 districts completed save for solar power installations ... 90% complete to be done by May 2021
Bio-digesters	3	Builders .	Average grant of US$1,500 per farmer	Look and learn visits organised for farmers. Training on the use of the technologies by the contractors	For heating and environmentally friendly waste disposal. One at PIB and two at lead farmers. Farmers provided local material and labour.
Solar powered water conveyance systems (pumping from boreholes and open wells)	7	Procurement and installation of the green technology equipment			Water for piggery, goats and fodder irrigation.

Source: VALUE project green technology template. It is important to note that numbers implemented, services, grants and trainings provided continue to change upward as project implementation progresses.

2.6 Green technology services, grants and trainings by ZAKIS project

The ZAKIS project being implemented by WHH in partnership with SAT, ICRISAT and Community Technology Development Organisation (CTDO) has as its objective to transform Zimbabwe's agricultural research, education and extension services for the future. It does this partly through the establishment of Agricultural Centres of Excellence (ACEs) anchored by an agricultural college and agricultural research station and for this it is working with Chibero College of Agriculture and Matopos Research Institute. The goal of the ACE is to establish an integrated, dynamic, market-oriented, and farmer-centric agricultural knowledge and innovation services system that meets the needs of modern agriculture in Zimbabwe.

Further, the ACE seeks to develop and demonstrate a new business model around the agricultural research, education, and extension nexus that ensures financial sustainability and brings about continuity in the supply of integrated knowledge and innovation services to farmers and other agriculture value chain players[3].

ZAKIS has no budget line specific to green technologies. Green technologies development draws from the infrastructure development and establishment of communication centres budgets lines. About €112,494.34 representing 1.70% of ZAKIS's total budget of €6.6milluon has been spent of hardware type green technologies. ZAKIS supported the installation of solar power systems at administration blocks at Chibero and Matopos with the aim of reducing the power costs associated with the highly priced and often unstable electricity supplies and running backup diesel generators as well as the carbon footprint. In 2021, it installed solar powered water pumping system at Matopos for irrigation system covering 2 hectares for fodder crops and horticulture for revenue generation in addition to another solar powered irrigation system for 0.6 hectares for forage and legumes for stock feed that had been installed in 2019. At Chibero, ZAKIS installed three solar powered water pumping systems. Two are serving the animal and horticulture sections. The third pumps water from the night storage dam to ACE land drip irrigation. At the four District Agriculture Centres of Excellence (DACEs) namely Chegutu, Mhondoro-Ngezi, Matobo and Insiza, the project installed solar powered boreholes and drip irrigation.

Table 2.6 Green technology services, grants and trainings implemented by ZAKIS

Green technology	Project sites where green technology has been implemented	Services provided	Grants provided	Training provided	Comment
Solar systems for powering administration blocks	Chibero College of Agricultural (Solar system covering offices & lecture theatres to enhance student learning) Matopos Research Institute (5.5KVA solar system for lighting, powering equipment like laptops & internet, some small laboratory equip & refrigerator)	Project invited tenders, shortlisted and engaged contractors for the green tech installation.	Chibero – €5,638.61 Matopos – US$10,000	Operational training provided to focal persons at the centres by cotractor at hand over. Proper training to be done by contractor on operations & maintenance of the green tech.	Work considered good. All working according to plans. Had operational problems at Chibero which were rectified.
Solar powered water system	Chibero College of Agriculture (Borehole equipped with solar for the animal section- € 6.893.84. Borehole equipped with solar power for horticulture section - € 4,272.63. Solar powered pump installed to pump water from night storage dam to the ACE land drip irrigation- € 3,895.65. Matopos Research Institute (two boreholes, solarisation, drip, pump repairs to date for horticulture and forage crops fields ... first borehole irrigates 0.6ha & sec. 2ha) Each of the four DACEs: Chegutu – US$17,471.50; Mhondoro-Ngezi - US$17,528.50 ; Matobo (including sand abstraction) - US$20,510.00; and Inziza - US$17,590.40.	As above.	Chibero €15062,12 Matopos - US$24,892.68 DACEs – US$73,100.40	As above	The first horticulture cycle for Matopos raised US$1,300 with total cost being around $700 (labour included in calculation though covered by Public Service).

[3] Revised ZAKIS Annual report 2019-2020

2.7 Emerging points from implementation of green technology services, grants and trainings by projects

From the literature review, consultations with ZAGP projects and Government personnel and interviews with farmer representatives as well as observations during field visits, the following points are emerging from the implementation of green technology services, grants and trainings to date:

2.7.1 The selection of green technologies by the different ZAGP projects are meant to address energy related issues of heating, lighting, cooling and powering equipment like water pumps and battery powered tricycles for farm transport in ways that are environmentally sustainable. Apart from clarity of the issues being addressed, only the IPVC project has clearly defined criteria for the selection of green technologies which (criteria) are: low environmental impact, replicability and return on investments in one to two year period.

2.7.2 **Services**: The approach to provision of services has been the same across the six projects involving procurement and installation of the green technologies. The identification of service providers is through competitive bidding for supply and fix of the green tech hardware. Where appropriate, communities provide casual labour and local materials like in the construction of bio-digesters. There were cases of reported delays in procurement and hence installation of agreed green technologies, with solar power system for milk cooling at Goshen MCC in Chipinge under TranZ-DVC and the construction of the Mathambo CBC in Lupane under BEST being examples. The delays were attributed to challenges related to centralised procurement systems serving national programmes with big volumes. Any delays in installation also entail delays in green tech impact being realised. Other concerns picked during site visits were that farmers would have preferred bigger solar power units to power wider ranges of enterprise activities and speedy address of functionality issues relating to some solar powered incubators.

2.7.3 **Grants**: Three approaches are being used in funding green tech pilots. First is one where some projects are providing hundred percent grants for green technologies installed at institutions as in the case of ZAKIS at Chibero College of Agriculture and Matopos Research Institute and as public goods in the cases of AAHMC under SAFE, CBCs under BEST and GICs under VALUE. The second approach is one where recipients give 10% of cost of the installed green technology to their respective farmers association as their contribution, as in the case of green technology grants under IPVC. The 10% is payable over time and not up front. IPVC has also used total grant approach for the battery powered tricycles. The third method is that of matching

Text Box 2.7.3

*The Nharira Lanchashire Dairy Farmers Association in Chivu District was supported by SNV in the past. Around 2014, seventeen out of the current 45 active members were assisted to install biogas digesters with farmers putting in about 75% of the total cost per bio digester. SNV had exposed the smallholder dairy farmers to the technology through learning visits to Mhondoro where such technologies had been implemented. Since then some farmers (exact number not known) in and out of the Association were said to have installed bio-digesters using own resources without external support. This suggests that a limited project resource can be made to reach more beneficiaries if the latter are made to contribute. It also shows that smallholder farmers can use own resources to acquire appropriate technologies once they appreciate its benefits. (**Source:** interview with Committee Members of the Nharira Lanchashire Dairy Farmers Association)*

*The inferences from the Nharira experience, above, are corroborated by an experience at Goshen MCC of Rusitu Small Scale Dairy Farmers Cooperative Society, Chipinge District. At Goshen, one farmer was assisted by SNV to install a demonstration 13 m^3 bio-digester in 2014/15 at a cost of about US$2,800 with the farmer contributing 70% of the cost in the form of local and purchased materials and labour. Another farmer, female member of the MCC, set out to build her own bio-digester with own resources and SNV later chipped in to help her. She put in more than 70% of the total cost of the bio-digester. The same lady indicated that she knows of another female member of the Dairy group who is working to construct a bio-digester on her own. (**Source**: Interview with Mr Z. Mutengu and Ms A. Moyo at Goshen MCC..two farmers with bio-digesters built with support from SNV)*

grants. TranZ-DVC and VALUE are using this matching grant approach whereby the farmers meet at least 30% of the total cost of green technology with the project granting 70%.

2.7.4 While four projects, VALUE, BEST, SAFE and ZAKIS, are supporting installation of tried and tested technologies such as bio-digesters and solar power systems for lighting, heating and cooling and water conveyance, the other two, IPVC and TranZ-DVC, are going for both tried and tested technologies as well as novel technologies being piloted under Zimbabwe conditions. Examples are battery powered tricycles under both projects and rocket stove and saw dust pellet plant under IPVC. The tricycles are a new green technology from China. The pilots in Goromonzi under IPVC and Chipinge under TranZ-DVC are revealing need to address issues relating to distances battery can last between recharges, wheel sizes, cover from weather elements when operating under rainy or windy conditions and absence of a national policy on electric vehicles as regards driving licences. The Rusitu Small Scale Dairy Cooperative Society which is recipient of four battery powered tricycles was engaging the supplier, Mobility for Africa, on among other things the aforementioned technical issues of the tricycles. Mobility for Africa is using the pilots for feedback and is engaging relevant GoZ departments and Ministries on policy on electric vehicles. The rocket stove was piloted at a lead farmer in Ntabazinduna, IPVC Bulawayo cluster, and had operational issues relating to its electric parts (particularly the fan) and the firewood chamber. The farmer has used his engineering background to modify and produce an adapted version (re. Annex 5.4.5).

2.7.5 **Training** comes in various forms including look and learn visits under IPVC and VALUE projects and farmer training on smart climate dairy farming practises including water harvesting, conservation farming, fodder and use of renewable energy under TranZ-DVC. Contractors also provide training on the use of green technologies they install. In addition, some hands on training comes in the form of participation by community members in the installation of green technology by providing unskilled labour and local resources, for instance during construction of bio-digesters under BEST, IPVC, TranZ-DVC and VALUE projects and trenching for piping for solar powered water systems under the same projects. Farmer and/or committee members at for example CBCs, GICs and MCCs, are also receiving training on operating the installed green technologies. The trainings are provided by the contractors after installation. Operating / user manuals are also given to farmers.

2.7.6 **Green technology uptake by farmers** is a function of a number of factors including appreciation of the technology by farmers, affordability of the green technology by small holder farmers and capacity to install and sustain the technology. Appreciation derives from the exposure to and training on the green technologies. Plans for farmer exchange and learning visits have been restricted by the Covid19 pandemic. Consequently learning visits across projects and green technologies have been limited due to travel restrictions in the past one and half years. The period coincides with the time most installations were done. Farmers and farmer representatives met during field visits indicated that there was some interest in green technologies like solar power systems and bio-digesters under different projects but Covid19 has been a spoiler for exchange visits for look and learn. Another view was that technologies like bio-digesters and tricycles were considered desirable but the issue of economic accessibility by small to medium (StM) scale farmers due to high installation / procurement costs could be a limiting factor.

2.7.7 **Financial limitations** potentially affect uptake of green technologies by StM farmers. Green technology site visits, however, revealed that some StM farmers are installing some of the green technologies using own funds or by investing more than is required by the matching grant facilities. Examples of such cases met during the green technologies site

visits are captured in Text Box 2.7.7. Interviews with StM farmers during the site visits revealed they had strong entrepreneurial aptitudes coupled with determination to grow their businesses and improve the welfare of their households. Most StM farmers and their representatives met during site visits were aware that the green technology installations at lead farmers under the ZAGP projects are pilots for demonstration so other farmers can learn and adopt. A concern raised by many is that of affordability.

Text Box 2.7.7

Mr Joseph Chinyangare is a poultry and pig farmer in Ward 14, Chegutu District. IPVC gave him a grant of about US$6K for installation of a 20m³ tubular bio-digester for heating and lighting in 2021. The digester is fed with waste from piggery. From his own resources he installed 3 solar systems for (a) domestic lighting and refrigeration - 2016 (b) powering borehole – 2020, and (c) lights for chickens – 2020 for a combined cost estimated at US$2K.

Mr Washington Sagonda is a dairy farmer and chairperson of Tsonzo MCC in Mutasa district. He was granted +US$4,200 for a 60m deep borehole equipped with solar pump for 2ha pasture irrigation under the TranZ-DVC matching grant facility in 2019 - 2021. At the time of site visit, he had put in US$4,200 of his own resources instead of 30% of the grant. His input covered costs of borehole siting, 9,000 litre storage dam construction, fencing for the two hectares, water system pipes and irrigation kit.

Ms Dorcas Zikhali and her husband Dingilizwe Ndlovu are goat farmers in Ward 1, Lupane district. They were granted US$2,100 for 300W solar panels, a portable water pump and a 5K litre tank by VALUE in 2020. They claimed to have put in more than the required 30% match through investment in piping and trenching connecting to a perennial 3m deep well that is 300 meters from homestead, tank and pasture garden and drip irrigation kit.

Pig Industry Board in Goromonzi district is working with VALUE promoting adoption of bio-digesters by pig producers. According to VALUE Project Green Technologies Template "Other farmers are also adopting the technology using own funds".

Market linkages with financial institutions are viewed as having challenges for most StM farmers and more workable with large scale farmers. TranZ-DVC has engaged Zimbabwe Women's Microfinance Bank, BancABC, ZADT and AgriBank, linking 1350 (945 female and 405 male) farmers to the financial institutions. BEST project engaged Steward Bank, CBZ, Quest MFI and ZADT and VALUE project engaged AgriBank, Empower Bank, Metropolitan Bank with a view of linking StM farmers to financial services providers. StM farmers met during site visits lamented that small holder farmers are price takers for their produce. Consequently, margins are small and not guaranteed to give them confidence to go for loans. VALUE Project Interim Narrative Report FY2 reports that *"Credit uptake for SMPs (small to medium producers) was low as loan facilities under financial institutions remained parallel to pigs and goat production realities. The project will continue engaging with financial institutions in attempt to co-design credit packages that allow win to win arrangements. This initiative will ensure that farmers have access to services being offered by formal financial institutions."* Another option suggested by some farmers met during site visits is that of ISALs whereby farmers could take turns to install green technologies for each other. TranZ-DVC, for example, is promoting the formation of 149 ISAL groups which could be used for adoption of green technologies by farmers supporting each other at group level.

2.7.8 The **pilots are whetting farmers' appetite for green technologies**. Committee members at Mathambo CBC in Lupane, indicated that many cattle farmers willingly participated in the establishment of the demonstration bio-digester at a female cattle farmer and are keen to install similar facilities at their homesteads as evidenced by enquiries on the cost of installation. Representatives of two

Text Box 2.7.8

"Our vision as a group is to help each group member to eventually own a hamba (i.e. tricycle) when they are available for sale to individuals." Ms Furasiya Manduna, a Domboshava poultry farmer and leader of Group 1, Ward 4, Goromonzi district, 30/07/21. As group leader, the tricycle provided by IPVC is kept at her home but is available for use by the other four members of the group.

"I know of four people that have pegged sites for bio-digesters. The excavation has not started. They are being held back by the high cost of constructing the structures." Remark by a discussant at Mr Ndabezihle Nkomo' bio-digester site at Nyamandlovu, Umguza district, where BEST supported the construction of a 6m³ dome bio-digester.

poultry farmer groups in Domboshava, IPVC Harare cluster, who received battery powered tricycles indicated that many farmers outside the poultry producer groups are enquiring how they can access the tricycles, though not all would be thinking of them in relation to farm produce transport. Rusitu Small Scale Dairy Cooperative Society, recipients of four tricycles, is engaging supplier, Mobility for Africa, for fifty battery powered tricycles for their members who are all small scale dairy farmers. A pig producer in Murehwa district, who was assisted with a grant to upgrade waste management system by VALUE is keen to install a bio-digester feeding from the piggery waste as soon as his resource situation permitted. The farmer saw a bio-digester at work at the Pig Industry Board (PIG). PIB has received support from VALUE project and is reportedly promoting adoption of bio-digesters by pig producers using their own funds.

3.0 ANALYSIS OF IMPLEMENTATION PLANS FOR SERVICES, GRANTS AND TRAININGS AND POTENTIAL IMPACT OF THE GREEN TECHNOLOGIES IMPLEMENTED

The terms of reference require an analysis of existing implementation plans for these services, grants and trainings, estimating the potential impact of what has been implemented to date and recommending changes to be made to the way they are implemented.

Sections 3.1 to 3.6 present the implementation plans for services, grants and trainings by projects with recommended changes on the way services, grants and trainings are being provided. Section 3.7 then presents a matrix of expected outcomes and potential impacts of the different green technologies being implemented under ZAGP projects.

3.1 Implementation plans for services, grants and trainings by BEST project

Implementation of green technologies services, grant and trainings under the BEST project remain largely work in progress. The plans are for each of the 10 CBCs to have (a) an administration block fitted with solar system for lighting, refrigeration for vaccines and other drugs and to power computers, internet, etc (b) solar powered water supply system for animals and fodder crops irrigation, and (c) a demonstration bio-digester at a lead farmer or at CBC. Table 3.1 below shows achievements and outstanding planned work.

Table 3.1 BEST's green technology services, grants and trainings plan

CBC	Technologies implemented	Green technology outstanding per plan	Budgeted grants for technologies
Dotiti – Mt Darwin District	Solar powered borehole	a) Solar power system (office lighting, computers, internet, drugs & vaccines refrigeration) b) Bio-digester	Budget for solar power system €6,000 Budget for Bio-digester €2,966
Mutiusinazita – Buhera District	Solar powered borehole.	a) Bio-digester b) Solar power system (office lighting, computers, internet, drugs & vaccines refrigeration)	Budget for Bio-digester €2,966
Chachacha - Shurugwi	-	a) Solar powered borehole b) Solar power system (office lighting, computers, internet, drugs & vaccines refrigeration) c) Bio-digester	Budget for borehole system €11,864 Budget for solar power system €6,000 Budget for Bio-digester €2,966
Dendera - Kwekwe	Solar powered borehole	a) Solar power system (office lighting, computers, internet, drugs & vaccines refrigeration) b) Bio- digester	Budget for solar power system €6,000 Budget for Bio-digester €2,966
Mateta – Gokwe South District	Solar powered borehole	a) Solar power system (office lighting, computers, internet, drugs & vaccines refrigeration) b) Bio- digester	Budget for solar power system €6,000 Budget for Bio-digester €2,966
Umguza – Umguza District	Solar powered borehole (pump later removed owing to borehole low water yield) Bio-digester.	a) Solar power system (office lighting, computers, internet, drugs & vaccines refrigeration)	Budget for solar power system €6,000
Mathombo- Lupane District	Solar powered borehole Bio-digester	a) Solar power system (office lighting, computers, internet, drugs & vaccines refrigeration)	Budget for solar power system €6,000
Mayo – Makoni District	Solar powered borehole	a) Solar power system (office lighting, computers, internet, drugs & vaccines refrigeration) b) Bio- digester	Budget for solar power system €6,000 Budget for Bio-digester €2,966
Lapache – Mwenezi District	Bio-digester Solar powered borehole	a) Solar power system (office lighting, computers, internet, drugs & vaccines refrigeration)	Budget for solar power system €6,000
Muhlanguleni– Chiredzi District	Solar powered borehole. Solar power system (office lighting, computers, internet, drugs & vaccines refrigeration)	a) Bio- digester	Budget for Bio-digester €2,966

It is important to note that the numbers of green technologies outstanding per plan continue to change downward as project implementation progresses.

Green technologies at CBCs are for use by communities and therefore a public good. The current approach to services, grants and trainings may continue to deliver on the green technologies that are community assets. However the approach to demonstration bio-digesters may need to be reconsidered. The ones installed at lead farmers homestead in Lupane and Mwenezi districts were reported fully paid for by the project save for unskilled labour and local resources provided by the lead farmers. The project could consider matching grant approach for demonstration green technology whose functionality is tested and proven. This way farmer ownership of the asset is strengthened, more demonstrations can be installed from the same grants and it can be shown that farmers can adopt the assets using own resources.

3.2 Implementation plans for services, grants and trainings by IPVC project

IPVC green technologies implementation is work in progress with the outstanding planned deliveries as shown in Table 3.2. The mode of delivery in terms of services, grants and training remain the same as that has been used to date.

Table 3.2 IPVC's green technology services, grants and trainings plan

Green technology	Number outstanding per plan	Target beneficiaries	Budgeted grants for technologies	Comment
Tubular bio-digester	4	Lead farmers	US$6,167 per set	For heating brooders.
Rocket stoves	47	Lead farmers	US$1,200 per unit	For heating brooders
Saw dust pelleting plant	1	Mutare PBA	US$8,895	Pellets for use in rocket stoves
Solar incubators	11	Lead farmers, Farmer groups and PBAs	US$2,666 per unit	For hatching of dual purpose and indigenous chicks
Battery powered tricycles	11	Farmer groups	US$1,250 per tricycle	For egg distribution and marketing

Source: IPVC Presentation at TA-ZAGP Focused Coordinating Meeting, April 2021. It is important to note that the numbers of green technologies outstanding per plan change downward as project implementation progresses.

The IPVC green technologies delivery model of farmers contributing 10% equivalent of total cost to their Associations has potential drawbacks that include absence of (a) specific timeframes within which the farmer pays the Association, and (b) mechanism to enforce the payment. A strong view was expressed by some interviewees that IPVC should consider having individual farmers have a fixed matching contribution for tested and proven green technologies to enhance sense of ownership, reaching out to more farmers with the limited project resources and demonstration pieces.

Where the technology is not proven and being tested, then matching grants would not be suitable. Especially if the technology fails to prove appropriate e.g. the case of the Rocket Stove by A Ntabazinduna, Bulawayo cluster poultry farmer under the IPVC project. The project should also consider addressing some seeming inconsistencies whereby some grant recipients, e.g. for solar power and bio-digesters, pay 10% of total cost to PBA while others, e.g. tricycle recipients groups indicated they were not aware if they will be required to pay anything. It could be the battery powered tricycles are being regarded as being a novel technology being tested or that the recipients are groups and not individuals. Whatever the case may be, IPVC need to provide grant policy clarity.

3.3 Implementation plans for services, grants and trainings by SAFE project

SAFE is piloting solar power systems at two AAHMCs, namely Nyamizira AAHMC in Makoni district and Nyava AAHMC in Bindura district. Based on learnings from the two pilots the green technology will be rolled out to the remaining proposed 24 AAHMCs across the country making a total of 26 AAHMCs equipped with solar power systems.

Table 3.3 SAFE's green technology services, grants and trainings plan

AAHMC	Green technology implemented as planned	Green technology outstanding per plan	Estimated grant for outstanding technologies	Comment
24 AAHMCs in 24 districts across the country.	Solar power systems at AAHMC	24 solar power systems for lighting, powering computers, printers and internet, cold chain storage for vet drugs and vaccines.	US$$8.5K per AAHMC giving a total of US$204K.	Installation at the remaining proposed 24 AAHMCs will draw lessons from the two pilots in Makoni and Bindura districts and is expected to be completed by end November 2021.

The modus operandi of (a) sourcing a contractor(s) on a competitive bidding basis for the installations (b) project paying the total cost of installation and (c) contractor training the focal persons from DVS and PSPs at AAHMCs on operations of the system is planned to continue

for the remaining 24 AAHMCs. In view of that the AAHMCs will be public good the approach to providing services, grants and trainings is considered appropriate for the planned installations. However, an area for consideration is that of planning for the replacement of the system since the components have fixed life spans. To this end, SAFE is engaging the private sector for win-win partnerships with DVS with the former taking some responsibilities for maintenance and replacement over time.

3.4 Implementation plans for services, grants and trainings by TranZ-DVC project

TranZ-DVC support to green technologies in promoting climate smart dairy farming has been through the Matching Grant Facility where the project pays seventy percent (70%) of the cost of productive asset and the farmer, integrator or processor chips in with thirty percent (30%). The MGF is premised on farmers, integrators and processors applying for support when funding windows are open. Since the start of the project, there has been three such windows. The MGF, however, deliberately emphasises on purchase of climate smart productive assets like solar and biogas energy assets. Unlike other ZAGP projects, it is not possible to plan for specific green technology assets because the MGF is dependent on expressed needs of applicants.

Plans are for the matching grant approach to continue for the remaining €1.609million MGF budget, linking farmers, integrators and processors to financial houses for future funding of acquisition of climate smart productive assets and raising awareness on climate smart agriculture including green technologies through training. The matching grant approach to delivering green technologies has some clear positives in terms of reaching out more beneficiaries, allowing farmers to choose investments on what they consider to add value to their businesses.

There is, however, a view that a fifty percent matching grant should have been used for private good assets. The aforementioned experiences with SNV matching grants for bio-digesters and other green technologies around 2014/15 are referred to in support of this view. The proposed increase in ratio to 50:50 would apply to all ZAGP projects matching grants for assets that are of a private good nature. This will instil the farming as a business mind set, stimulate entrepreneurship, allow for more farmers to be reached and enable demonstration that farmers can adopt green technologies using own resources. Easy funds can easily promote a donor dependency mentality on the part of recipients. The Rusitu Dairy Small Scale Dairy Cooperative Society, for example, has enjoyed funding support from ARDA in the 1990s, Stabex around 2010, Land O'Lakes 2012 – 2014, Fintrec 2014 – 2015, USADF 24 – 2021, SNV 2016 – 2017 and now TranZ-DVC 2016 - 2023. There is potential for creating donor dependency.

3.5 Implementation plans for services, grants and trainings by VALUE project

The VALUE project has a budget €125,454 set aside for smart subsidies and US$20K set aside per GIC centre construction. The twelve GICs are complete with solar power systems and solar powered boreholes. For the GICs the project provided all purchased inputs including hiring of contractors with communities providing local materials and support labour. For the smart subsidy grants, projects puts in 70% of total cost of asset with maximum grant size €5,400, average grant size €1,394. The farmer puts in a match of thirty percent of cost of asset. The farmer's contribution can be in cash or in kind. To date 51.16% of the budget has been disbursed as grants. Farmers apply for the grants under the smart subsidy fund on the basis of their needs which can be green technology assets, e.g. solar power system, solar power water conveyance system, bio-digesters, waste management system or other needs such as breeding stock. Because the smart subsidies are premised on farmer

applications that are need based, it is not possible to say what green technologies will be applied for and implemented with the smart subsidies budget balance.

The approach of 70:30 contribution by project and farmer has advantages of promoting commitment, ownership and entrepreneurship mentality on the part of farmer. It also promotes farming as a business as it requires farmers to show commitment by contributing to procurement of productive assets. The limited project budget covers more farmers than would be the case if the project was funding 100% of asset costs. In Section 3.4, above, an argument has been advanced for the project to farmer ratio to be increased to 50:50.

The contribution of local materials and farmer participation in implementation of green technologies was an important part of training for the farmers. The area of training was appreciated by the farmers met during site visits. However, more could have been achieved in this area were it not of Covid19 restrictions that limited farmer exchange visit for learning.

3.6 Implementation plans for services, grants and trainings by ZAKIS project

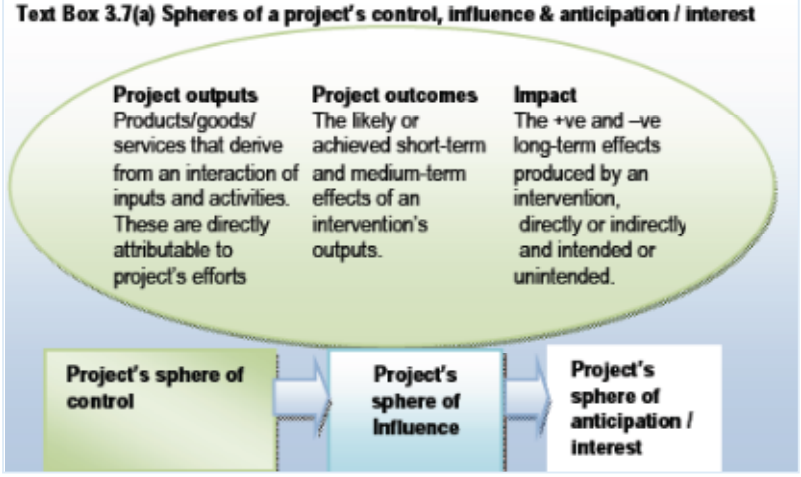
ZAKIS is currently supporting the construction of administration offices at four DACEs, namely Chegutu, Mondoro-Ngezi, Matopo and Insiza. Each of the administration offices will be equipped with solar power systems for lighting, communication and powering of office equipment like computers and printers. The solar power systems are included in the budgets for the development of infrastructure, i.e. office blocks. There will not be fixed contributions by the stakeholders specifically for the solar power systems. Stakeholder contribution will be subsumed in that they put towards the overall establishment of the DACEs. This is considered appropriate in that DACEs are a pilot programme and a public good. The project will identify contractors through competitive bidding for the solar systems installations. The contractors will also be required to train the DACEs focal persons on the operations of the installed systems.

The project, ZAKIS, has plans to enhance the efficiency of the solar powered water systems at the two ACES, Chibero and Matopos, by installing chameleon sensors for irrigation scheduling. The same approach used to date, whereby project identifies contractors through competitive bidding, provides full grant for the supply and fix of green technology and contractor trains the focal persons at the ACES on the operation of the technology, is envisaged for the installation of the sensors. The approach is considered appropriate for delivering on green technologies as part of piloting the establishment of ACES premised on public institutions which are a public good.

3.7 Possible outcomes and potential impacts of green technologies

A project or intervention has three classes of results, namely outputs, outcomes and impacts. Outputs are the products, goods and/or services that derive from an interaction of inputs and activities. Outcomes are the likely or achieved short-term and medium-term effects of an intervention's outputs. Impact is the positive or negative, primary and secondary long-term effects produced by an intervention, directly or indirectly and intended or unintended.[4] So defined, outputs are within the sphere of control of a project while outcomes are within the sphere of influence and impact within the sphere of anticipation or interest of a project as there are many factors and players with bearings on both outcomes and impacts. The long term nature of impact is such that it may be realised or manifest long after the project period. Given this long term nature of impact manifestation, this assignment can only infer on potential impacts of the green technologies implemented under the ZAGP projects. In order to make the inferences the assignment looks at the outcomes, realised and/or possible, to get pointers on likely impact there from.

Text Box 3.7(a) Spheres of a project's control, influence & anticipation / interest



In an attempt to get pointers to realised and or possible outcomes and likely impact, farmers were asked about benefits accruing from green technologies implemented and the opportunities and threats they envisaged from the technologies. Responses touched on socio-economic, health /well being and environmental issues as shown by a sample of excerpts captured in Text Box 3.7(b) from discussions at different green technology sites that were visited. The discussions at project sites informed the matrix of outcomes and potential impact of the green technologies being implemented by the six ZAGP projects given in Table 3.7.

Text Box 3.7(b)

"*Biogas is more efficient than firewood. It takes a short time to prepare a meal .... this is good, especially for elderly people like the couple here who have diabetic problem, as they can prepare their food quickly anytime ... it saves them the hustle of collecting firewood and making fire .... it also helps in conserving the trees and there are no running costs like with ZESA (electricity).*" Discussant at Ndabazihle Nkomo bio-digester site, Nyamandlovu, Umguza district, 4/08/21. The bio-digester was installed with support from BEST.

"*The solar system powers the freezer, lights, television and radio ... ZESA was expensive and unreliable .... and when it was down due to load shading or fault we would transport milk every other day to Dendairy depot which is 30km away. Since the system was installed in November 2020, our ZESA (electricity) consumption has dropped from 300KW to less than 100KW per month which is a good saving on the costs of running the dairy.*" Mr Albert Ncube, dairy farmer, Claremont, Bulawayo, 6/08/21. System was installed for US$3,200 with TranZ-DVC support.

"The tricycles are helping strengthen social cohesion. The group members sharing a tricycles have to work together harmoniously using a common asset .... the tricycles are building confidence and positive self-esteem among women as they go on wheels and occupy leadership positions in groups." Ms Melody Zvekare, poultry farmer and Group 3 leader, Domboshava, Goromonzi district, 30/07/21. Tricycles supplied under IPVC project.

"*My ZESA bill was between $200 and $300 to raise a batch of between 3.5K and 8.5K birds. With the solar power system installed at a total cost of US$5,150 my ZESA bill is down to $40 per cycle and electricity is now used for powering borehole.*"Mr Tafadzva Charumbira, poultry farmer and PBA chairman, Goromonzi district 29/7/21. IPVC funded the solar system in 2020.

[4] INTRACT for Civil Society, 2017.

Table 3.7 Matrix of outcomes and potential impacts of the different green technologies being implemented under ZAGP projects

Green technology	Projects implementing technology	Possible outcomes	Anticipated impact
Bio-digesters (Tubular and Fixed Dome)	BEST IPVC TranZ-DVC VALUE	Reduced dependence on firewood and unreliable energy supplies in poultry production and domestic use ... labour saving and increased business margins for farmers Reduction in carbon monoxide emission from use of firewood and charcoal. Sustainable waste management & digestate feeding into farmers fodder and vegetable gardens. Increase in knowledge of clean energy, renewable energy sources and increasing number of farmers adopting the technologies.	Contribution to cleaner and sustainable environment. Improved livelihoods and households wellbeing. Improved farmer resilience amid climate change shocks.
Rocket stove	IPVC	Reduced use of firewood ... labour saving & increased business margins for poultry farmers. "*Stove uses a1/3 to ¼ of firewood used by drums that StM farmers use for heating brooders*." Mr Ntaa Khumalo, Ntabazinduna, Bulawayo cluster, 3/8/21.	Contribution to a sustainable environment. Improved livelihoods and households wellbeing.
Solar powered incubators	IPVC	Elimination of recurrent energy costs and reduced dependence on unreliable energy supplies ... increased productivity and production as chickens multiply faster .... Increased business margins for farmers. Improved social organisation from the poultry farmer groups & women exercising leadership.	Improved livelihoods of poultry farmers. Improved efficiency of Matopos Research Institute poultry section. Social harmony from working in groups. Confident women taking leadership positions
Solar power systems for lighting (Photovoltaic) and cooling.	IPVC TranZ-DVC VALUE ZAKIS	Elimination of recurrent energy costs & reduced dependence on unreliable energy supplies ... increased business margins for farmers & cost saving for Agric College and Research Institute leading to financial stability and sustainability.. Increase in knowledge of clean energy, renewable energy sources and increasing number of farmers adopting the technologies. Colleges and research institutes building on the technologies to increase their research and teaching capacities, e.g. it was indicated that GoZ is planning to drill 3 more boreholes at Matopos to irrigate an additional 3 to 4ha at the plot developed with ZAKIS support.	Improved livelihoods of poultry, beef, dairy, pig and goat farmers. Improved operational efficiency of Agric Colleges and Research Institutes. Other colleges and research institutes drawing lessons and inspiration from the ACEs and implementing similar technologies.
Solar power systems for: a) CBCs and GICs – powering lights, internet, computers, & drugs & vaccines cold chain storage. b) Admin. blocks - lights, computers, lab equipment, internet, etc.	BEST VALUE TranZ-DVC SAFE ZAKIS	Reduction of recurrent energy costs, reduced dependence on unreliable electricity supplies and reduced carbon footprint from diesel powered generators leading to increased business margins for farmers and cost saving for Agric Colleges and Research Institutes. Improved communication and information sharing ... ease of doing business. Farmers accessing veterinary medicines and vaccines in close proximity ....elimination of transport costs .... increased business margins for farmers.	Improved livelihoods of poultry, beef, dairy, piggery and goat farmers. Improved operational efficiency of Agric Colleges and Research Institutes.
Solar powered water systems including boreholes and wells.	IPVC? BEST TranZ-DVC VALUE ZAKIS SAFE?	Elimination of recurrent energy costs .... increased farmer business margins. Reduction in carbon monoxide emission from use of diesel powered pumps. Agric. Colleges and Research Institutes generating revenue from irrigation projects and reducing dependence on fiscus.	Contribution to safe and sustainable environment. Improved farmer resilience amid climate change shocks. Agric Colleges and Research Institutes able to better focus on their core business.
Battery powered tricycles	IPVC TranZ-DVC	Improved transport system for farmers ... increased business margins ... reduced reliance on donkeys and injury (to donkeys) from carrying loads of milk in mountainous areas. Improved social organisation from the poultry farmer groups & women exercising leadership.	Improved livelihoods of poultry and dairy farmers. Social harmony from working in groups. Confident women with positive self-esteem.

4.0 ANALYSIS OF IMPACT TRACKING MECHANISMS FOR THE GREEN TECHNOLOGIES BEING IMPLEMENTED BY ZAGP PROJECTS

The terms of reference require a review of the green technology impact tracking mechanism with each project individually, and suggesting changes where necessary.

4.1 Framework for tracking green technologies implementation progress and impact

From discussions on green technology impact tracking with the different ZAGP projects personnel, there is an emerging consensus on pointers to outcomes and potential impact. Data and information would need to be collected on the following variables to get the pointers (except for ZAKIS that is discussed separately in Section 4.7):

a) Green technologies implemented, by type,
b) Numbers of farmers/ households benefitting from the green technologies,
c) Numbers of animals, by type, benefitting from the green technologies,
d) Functionality and effectiveness of the green technologies implemented,
e) Uptake of green technologies by new farmers/producers (as well as integrators and processors and satellite CBCs in the case of beef value chain) within and without the farmer group structures established or strengthened by the ZAGP projects .... factors for and against uptake,
f) Uptake of green technologies by farmers outside livestock value chains, e.g. crops and horticulture farmers,
g) Changes the technology has brought to the households and community ... social, economic, health/wellbeing, etc
h) Return on investment ... number of years it would take to recoup the investment,
i) How is the environment benefitting from technology ... from perspective of farmers and key informants, and
j) Testimonies of beneficiaries and case studies ..... how the green technologies are making a difference to farming businesses and household socio-economic wellbeing.

Impact takes time to manifest and it is likely that the full impact of green technologies being implemented under ZAGP projects may well be felt and noticed long after the projects have ended. For this reason, it is imperative that there be continuous tracking mechanisms at livestock value chain levels beyond the ZAGP projects timelines. Sections 4.2 to 4.7, below, presents proposed green technologies impact tracking mechanisms, project by project.

Besides the continuous tracking an appreciation of the green technologies outcomes and potential impacts can also be achieved through evaluations at either program or project levels. Such evaluations can be green technologies specific or be imbedded in program or project wide evaluations. If the latter, it would be important to ensure that sections of the evaluations are dedicated to green technologies and cover the aforementioned variables. The continuous tracking will then build on that.

Consultations with projects personnel indicate that (a) ZAGP projects will be conducting end line or summative evaluations (b) one of the projects, IPVC, has a green technology evaluation lined up, and (c) some projects have no budgets for standalone green technologies evaluations. In view of this, it is proposed that:

d) Each ZAGP projects includes a section on green technology outcomes and impact assessment in its end line evaluation addressing the variables outlined above,

e) Any ZAGP project conducting a standalone green technologies outcomes and impact assessment ensure that all variables outlined above have been addresses in the terms of reference of the evaluators, and
f) That TA-ZAGP commissions a meta-analysis exercise premised on results of the different projects and green technologies specific evaluations thereby enabling the comparing and contrasting of outcomes and impacts of green technologies across the six projects. The exercise is to be done when all the six projects have done their end of project evaluations.

4.2 Green technology impact tracking mechanism of BEST project

4.2.1 Current BEST project green technologies impact tracking mechanism

BEST project is currently monitoring and reporting on green technologies as part of overall project performance monitoring focusing on output targets that include completion of CBC office blocks and installation of solar power systems at the offices, water systems and demonstration bio-digesters at lead farmers or at CBCs. As indicated in Section 3.1 the establishment of CBCs and installations of the related green technologies are still largely work in progress. It is, therefore, understandable that there is not yet green technologies impact assessment or tracking mechanism in place. BEST, however, is mindful of the need for these. It has plans to engage key stakeholders including farmers' organisations, relevant government departments like DVS and AGRITEX and LMAC with which it is already working with a view to develop transition plans outlining roles and responsibilities for various aspects of the project including monitoring and evaluation (M&E). BEST has already plans for an end line evaluation two months before project end.

4.2.2 Suggestion for BEST project green technologies impact tracking mechanism

In view of that BEST will be having an end of project evaluation, it is proposed that a comprehensive section on green technologies outcome and impact assessment be included in that evaluation. The evaluation terms of reference could thus have a section that addresses the variables outlined in Section 4.1 on framework for tracking green technologies implementation progress and impact. Results of this evaluation can then feed into the proposed meta-analysis exercise on green technologies implemented across ZAGP projects.

For the present and beyond the end of project evaluation, BEST can use the stakeholders consultations on transition plans to ensure that emerging M&E system incorporates a green technologies impact tracking mechanism. It is proposed that such a mechanism be nested in the farmer organisational structures that BEST is establishing and or strengthening at Ward and district levels. As part of the general monitoring information that these structures would be collecting and feeding up the reporting system they could also collect information on the following variables, on say a quarterly basis:

a) Green technologies, by type, installed or being installed by Ward and district,
b) CBCs with installed green technologies, by type,
c) Numbers of lead farmers with installed green technology, by type,
d) Number of farmers who have come on look and learn visits with a view of adopting the green technology,
e) Number of new farmers that have installed green technologies, by type .... in period under review,
f) How the new farmers are funding the installation of the green technologies,
g) Satellite CBCs that have installed green technologies, by type.... period under review,
h) How the satellite CBCs are funding the installation of the green technologies,
i) Numbers of farmers benefitting from green technologies at CBCs and satellite CBCs,

j) Numbers of animals, by type, benefitting from green technologies, by type, at CBCs and satellite CBCs.

Data collected on the above variables can be fed by CBCs into the Livestock Information Management System (LIMS) platform of DVS. LIMS is a platform that is being developed with support from ZAGP's SAFE project and testing expected in September 2021. The advantage of DVS hosting the LIMS is that it is a stakeholder in all the livestock value chains. DVS is actively involved at CBCs making feeding information into LIMS much easier.

4.3 Green technology impact tracking mechanism of IPVC project

4.3.1 Current IPVC project green technologies impact tracking mechanism

Among the six ZAGP projects, IPVC has invested a lot in studying different green technologies and tracking their implementation. The project is piloting eight different technologies as indicated in Section 2.2. The project engaged University of Genoa, November – December 2019, to conduct a scoping study of Green Technologies in IPVC's five clusters with the aim of listing promising technologies able to increase the efficiency of the value chain and to list best practices that enhance the quality of the process. It has also developed a green technology check list that seeks information from beneficiaries on use, effectiveness, efficiency, economics and environment. Its midterm survey household questionnaire has two questions relating to green technologies, namely the type of green technology being used and whether they have planted any trees if using the rocket stove. The project has also engaged Technical Assistance on green technologies evaluation. These efforts by IPVC are a base for a green technology outcomes and potential impact tracking mechanism proposed below for the value chain.

4.3.2 Proposed IPVC project green technologies impact tracking mechanism

If the proposed TA-ZAGP led green technologies outcomes and impact meta-analysis is conducted drawing from summative evaluations of the six ZAGP projects before the official end of the program IPVC would participate in the exercise by providing information from its own evaluation and other relevant exercises. In the meantime, the project has engaged Future Projects Consulting Africa as technical assistant on green technologies with responsibility of evaluating the interventions. The technical assistant was engaged August 2021 to March 2022. The consultants are already tasked to look at, among other things, most of the areas proposed in the meta-analysis framework as shown in Table 4.3.2.

Table 4.3.2 Areas IPVC consultants on green technologies are tasked to cover

Areas consultants already tasked to look at	Additional areas proposed for inclusion in consultants terms of reference
1. Type of green technologies implemented, and for each type, 2. Functionality and effectiveness of the installed green technologies .... is it working, not working and factors for and against, 3. Savings brought about the green technology .... cost, labour and other savings, 4. Changes in farmers and household incomes as a result of the technology, 5. Return on investment ... number of years its taking to recoup the investment, 6. Changes the technology has brought to the households and community .... social, economic, health/well being, etc ... from perspectives of farmers and key informants, and 7. How is environment benefitting from technology .... from perspective of farmers and key informants,	1. Numbers of farmers and households benefiting from green technologies, 2. Numbers of livestock, by type, benefitting from (i.e. served by) the technology, 3. Number of new farmers adopting the technology and how it's being funded .... farmers within and outside the project promoted farmer groups, namely PBAs, and 4. Testimonies and case studies on benefits accruing from the green technologies.

For the present and beyond the life of the project, tracking of green technologies impact is proposed to be nested in the farmer organisational structures that IPVC project is establishing / strengthening at local, district, provincial and national levels. As part of the general monitoring information that these structures are collecting and feeding up the reporting system they could also collect information on the following, on a quarterly basis:

a) Green technologies, by type, installed or being installed by Ward and district, at famer level,
b) Number of farmers who have come on look and learn visits with a view of adopting the green technology,
c) Number of new farmers that have installed green technologies, by type .... in period under review,
d) How the new farmers are funding the installation of the green technologies, and
e) Number of farmers with tree plantations to support their poultry business heating requirements.

The information collected at Ward level by the PBAs will be passed to district where it would be collated and passed on to the national level where the Zimbabwe Poultry Association collates and shares with LMAC for posting on the Poultry Information Management System (PIMS). IPVC is working with LMAC together with relevant government departments such as Agritex and DVS on the development of a PIMS to be housed by LMAC. IPVC is also collaborating with LMAC to continue nurturing and monitoring the PBAs beyond the life of the IPVC project. LMAC is an advisory council and for continuity in monitoring green technologies implementation progress and impact it is imperative that this be done by a Government department of which DVS is the most suited for reasons advanced in Section 4.2.2 under BEST. To this end it is proposed that tracking information collected by PBAs at district level be also fed onto the DVS LIMS platform. This responsibility can be carried by Agritex and DVS district level personnel.

4.4 Green technology impact tracking mechanism of SAFE project

4.4.1 Current SAFE project green technologies impact tracking mechanism

Currently SAFE is monitoring and reporting on green technologies as part of overall project performance monitoring focusing on outputs targets that include completion of green technologies installations. Other variables of interest like numbers of farmers and animals that benefitting are in relation to the AAHMCs of which the solar power system green technology is an integral component. It is, therefore, imperative for SAFE to go beyond outputs to outcomes and potential impact of green technologies.

4.4.2 Proposal for SAFE project green technologies impact tracking mechanism

The SAFE project is open to an outcomes and impact assessment conducted for green technologies implemented across the six ZAGP projects before the official end of the program as a standalone exercise or as part of the ZAGP end of programme evaluation. In addition, SAFE would like to include an outcomes and impacts assessment of its green technologies as part of its project summative evaluation. In both exercises, SAFE would like to see the assessment's terms of reference premised on an elaboration of areas indicated in Section 4.1.

In the meantime and beyond the life of the project, tracking of green technologies impact is proposed to be nested in the Livestock Information Management System (LIMS) platform of the Department of Veterinary Services (DVS). LIMS is being developed and testing expected in September 2021. DVS has personnel on the ground and will be overseeing AAHMC as

the regulatory authority. It is proposed that the following information be added to that being collected through the LIMS platform.

a) AAHMCs with installed green technology, namely the solar power system for lighting, cold chain storage and powering computers, printers and internet, etc.
b) functionality of green technology .... working and if not working what are issues,
c) servicing of the green technology,
d) savings brought about the green technology .... cost, transport and other savings
e) numbers of farmers benefitting from the installed green technology, by type, and
f) number of animals, by type, benefitting from the green techs at each of the AAHMCs,

4.5 Green technology impact tracking mechanism of TranZ-DVC project

4.5.1 Current TranZ-DVC project green technologies impact tracking mechanism

The TranZ-DVC project has various tools it is using to track progress of implementation of its activities including green technologies. The project conducted a baseline study in 2019 which, among other things, looked at renewable energy use at production and processing levels for lighting, cooking, heating, refrigeration, water pumping and milking by type of renewable energy (solar, biogas and wind) and by sector (A1 and A2 resettlements, small and large scale commercial, peri-urban and communal sectors). The baseline information serves as benchmark against which progress is reported in narrative reports. For example the TranZ-DVC 2020 Interim Narrative Report reports that *"In 2019, no processor using energy for pasteurisation and in 2020 there was one processor. Use of renewable energy for heating and cooling recorded 3 apiece from 2 in 2019. And use of renewable energy on water pumping by processors increased to 3 in 2020."* In addition to the narrative interim reports TranZ-DVC project has developed a Project Performance Dashboard which shows achievements against targets for all the project activities. The different TranZ-DVC partners feed data and information onto the dashboard. Baselines and regular progress reports against the same as well as use of a Performance Dashboard are all very good project monitoring practises by TranZ-DVC which other projects can emulate.

Current reporting by TranZ-DVC focuses on implementation progress. A quick look at narrative reports and the Project Performance Dashboard show reporting of achievements against targets. These are output measures. TranZ-DVC acknowledges the need to go beyond outputs and consider outcomes and potential impact. The project is conducting a project mid-term evaluation which it anticipates will help it look at outcomes and potential impacts. For the green technology, an impact tracking mechanism for TranZ-DVC is suggested in Section 4.5.2 below based on the framework, Section 4.1.

4.5.2 Proposal for TranZ-DVC project green technologies impact tracking mechanism

Like for other projects it is proposed that TranZ-DVC includes a comprehensive section on green technologies outcomes and impact assessment in its end of project evaluation. Such an evaluation's terms of reference could have a section that addresses the variables outlined in Section 4.1 on framework for tracking green technologies implementation progress and impact. Results of this evaluation can then feed into the proposed meta-analysis exercise on green technologies implemented across ZAGP projects.

For the present and beyond the TranZ-DVC project period the dairy farmers structures that the project is establishing or strengthening could be used to collect information on variables that give pointers on green technologies outcomes and potential impact. Information could be collected on the following, say on a quarterly basis:

a) Green technologies, by type, installed or being installed by Ward and district, at famer, integrator and MCC levels,
b) Number of farmers who have come on look and learn visits with a view of adopting the green technology,
c) Number of new farmers, integrators and processors that have installed green technologies, by type .... in period under review,
d) How the new farmers, integrators and processors are funding the installation of the green technologies, and
e) Numbers of farmers benefitting from green technologies at MCCs.

The information on the above could be collected by the dairy farmers' cooperatives and associations on a quarterly basis and fed into the Dairy Digital Data Gathering System (3DGS) which is scheduled for launch In October 2021 and will be nested at Zimbabwe Dairy Industries Trust (ZDIT). Data on (a), (c) and (e) is currently being captured on the aforementioned Dashboard and the other variables can be added as part of the move to the 3DGS. ZDIT can therefore take responsibility for tracking implementation and impact of green technologies within the dairy value chain.

4.6 Green technology impact tracking mechanism of VALUE project

4.6.1 Current VALUE project green technologies impact tracking mechanism

VALUE project is monitoring and reporting progress against targets of activities including implementation of green technologies at GICs and installations by goat and pig producers who receive smart subsidies. It has developed a template for green technologies showing responsible partner organisation, green technology description, district and Ward and name of farmer or institution implementing technology. The template is an output level compilation. The project appreciates the need to go beyond outputs to assessing outcomes and impact of all its activities. To this end the project has plans for an end of project evaluation which would enable it to assess outcomes and impact.

4.6.2 Proposal for VALUE project green technologies impact tracking mechanism

It is proposed that VALUE, like with other projects, includes a comprehensive section on green technologies outcomes and impact assessment in its end of project evaluation. The section would be designed to address variables outlined in Section 4.1 on framework for tracking green technologies implementation progress and impact. Results of the evaluation can then feed into the proposed meta-analysis exercise on green technologies implemented across ZAGP projects.

For the present and beyond the VALUE project period, GPBAs and PPBSs through their Business Management Units (BMUs) that are secretariats driving administrative logistics could collect information on variables that give pointers on green technologies outcomes and potential impact. It is proposed the following information be collected on a quarterly basis:

a) Green technologies, by type, installed or being installed by Ward and district, at farmer and GIC levels,
b) Number of farmers who have come on look and learn visits with a view of adopting the green technology,
c) Number of new farmers that have installed green technologies, by type .... in period under review,
d) How the new farmers are funding the installation of the green technologies,
e) Numbers of farmers benefitting from green technologies at GICs, and
f) Number and types of animals benefitting from the green technologies at GICs,

Data collected on the above variables can be fed by GPBAs and PPBSs' district level Business Management Units into the Livestock Information Management System (LIMS) platform of DVS through the Agritex and DVS district level personnel. LIMS is a platform that is being developed with support from ZAGP's SAFE project and testing expected in September 2021. The advantage of DVS hosting the LIMS is that it is a stakeholder in all the livestock value chains.

4.7 Green technology impact tracking mechanism of ZAKIS project

4.7.1 Current ZAKIS project green technologies impact tracking mechanism

ZAKIS currently is monitoring the achievements of targets of its various activities with the green technologies being considered part of the ACE physical and digital infrastructure development for an enabling environment. According to the ZAKIS Annual Narrative Report, August 2019 to July 2020, there were plans for the outcome monitoring surveys that were cancelled owing to the prevailing Covid19 lockdown restrictions. While these surveys may have been planned for the training and learning events at extension worker and farmer levels they would be a good practice that could be extended to other aspects of the project including green technologies. Outcome assessments of green technologies would help with pointers to impact, realised or potential.

4.7.2 Proposal for ZAKIS project green technologies impact tracking mechanism

It is proposed that, like for other projects ZAKIS includes a section on green technologies outcomes and impact assessment in its end of project evaluation whose results would feed into the proposed meta-analysis exercise on green technologies implemented across ZAGP projects. Given ZAKIS project's focus on building agricultural centres of excellence on research, education and extension the evaluation could consider addressing the following variables specific to agricultural colleges and research institutes:

a) Type of green technologies implemented, and for each type,
b) Functionality and effectiveness of the green technologies .... is it working, not working and factors for and against,
c) How are the ACEs benefitting from the technologies ... how is the green technology contributing to financial stability of the institutions as well as to the core business of the institutions being research and/or education and extension?
d) What other opportunities have the green technologies opened for institutions .... e.g. leveraging more investments in green technologies because of demonstrated positive results?
e) Has the green technologies had any unintended effects, negative and or positive?
f) Lessons learnt on the green technologies and how they are being shared with other agricultural colleges and research institutions.

For the continued green technologies impact tracking at present and beyond the life of ZAKIS as a project, it is proposed that the ACES and DACEs, in whatever reporting they do, such as annual reports to the Department of Agricultural Education and Farmer Training and Department of Research and Specialist Services of the Ministry of Lands, Agriculture, Fisheries and Rural Resettlement could include a section on green technologies. The section of the report would address the same issues as in (a) to (f) above. The Department would, therefore, play the role of tracking green technologies impact alongside its monitoring responsibilities.

5.0 ANNEXES

Annex 5.1 – Documents Consulted

1. ZAGP - Beef Enterprise Strengthening and Transformation ANNEX A2 - Full Application Form, 15 January 2016.
2. ZAGP - Beef Enterprise Strengthening and Transformation Annual Narrative Report : 1 February 2020 to 30 April 2021.
3. BEST 4YR Development and Implementation Plan (DIP) – Colour Coded.
4. BEST Logical Framework.
5. ZAGP – Inclusive Poultry Value Chain (IPVC) presentation at a TA-ZAGP focused coordinating meeting, April 2021.
6. ZAGP – IPVC Collaboration Between WHH and University of Genoa.
7. ZAGP – ZAKIS Annual Narrative Report – Period 1st August 2019 to 31st July 2020.
8. ZAGP – Transforming Zimbabwe's Livestock Based Value Chains for the Future ANNEX A.2 Full Application Form, 15 January 2016.
9. ZAGP - VALUE Interim Narrative Report for the period 2 February 2020 to 31 January 2021.
10. TranZDVC Annex 1 Updated Log-frame Matrix.
11. TranZDVC Annex VI Interim Narrative Report, January to December 2019.
12. TranZDVC Draft Baseline Report, August 2019.
13. TranZDVC – ZAGP Monthly Focus Meeting: Green Technology, April 2021.
14. ZAGP – SAFE PSC - Meetings Scale of Interventions, 14 July 2021.
15. ZAGP – SAFE Annual Report 2021.
16. GoZ, Zimbabwe Investment and Development Agency Act [Chapter 14:37], No. 10/2019.
17. GoZ, Treasury Circular Number 11 of 2020: Processing of Public Private Partnership Projects Following the Promulgation of ZIDA Act.
18. GoZ, Agriculture and Food Systems Transformation Strategy 2020 - 2025.
19. GoZ - MLAFWRR, Livestock Growth Plan, July 2020.
20. ZAGP-SAFE, Annual Report 2020 (1st March 2019 – 28th February 2020).
21. GoZ, National Development Strategy 1, 16 November 2020.
22. GoZ, Vision 2030: Towards a Prosperous and Empowered Upper Middle Income Society by 2030, September 2018.
23. GoZ, National Agricultural Policy Framework (2018 – 2030), First Draft 20 June 2018, MLAFWRR.
24. INTRACT for Civil Society 2017, Outputs, Outcomes and Impact.
25. IPVC – Green Technology Checklist Form
26. IPVC – Midterm Household Interview Questionnaire (v.7.0)

Annex 5.2 – Project Sites with Green Technology Activities Visited

ZAGP project site	Green technology activities	People consulted at project site	Date
IPVC – Goromonzi Solar Energy Pilot	Photovoltaic lighting system	Mr Tafadzva Charumbira (Farmer and Chairman of the Harare Cluster Poultry Business Association)	29/07/21
IPVC – Chegutu Tubular Biogas Pilot (Chegutu Ward 14)	Tubular Bio-digester for heating	Mr Joseph Chinyangare (Farmer)	29/07/21
IPVC – Domboshava × 2 sites.	Electric Powered Tricycles	Ms Furasiya Manduna (Farmer & Group 1 Leader) Ms Melody Zvekare (Farmer & Group 3 Leader) Ms Susan Mujati (Agritex Extension Supervisor for Goromonzi Wards 2, 4 and 7)	30/07/21
IPVC – Byo	Solar Incubator	Ms F. Moyo (Farmer and Group Leader)	03/08/21
IPVC – Figtree	Photovoltaic lighting system	Mr F. M. Ben Tesa (Farmer & Chairman of Byo Cluster Poultry Business Association)	03/08/21
IPVC - Ntabazinduna	Rocket Stove heating system	Mr Ntaa Khumalo (Farmer)	03/08/21
ZAKIS and IPVC - Matopos	Solar power systems for Admin block, poultry project lighting and incubator, boreholes water pumping and irrigation.	Mr Matekenya (Head of Institution) Mr Jephias Dera (Research Officer) Ms S. Sibanda (Technician) Ms Theresa Rukuni (Lab Technician)	04/08/21
BEST – Nyamandlovu (Umguza District)	Fixed Dome Bio-digester	Mr Innocent Sibanda (Chairperson Livestock Dev. Com.) Mr Paul Dube (VIDCO chair) Mr Christopher Ningo (Vice chair LDC) +4 men and 3 women (all farmers) who joined discussion.	04/08/21
VALUE – Lupane Ward 9	Solar powered water conveyance system for goats and fodder production garden.	Mr Dingilizwe Ndlovu husband to Ms Dorcas Zikhali (Goat farmer)	05/08/21
VALUE – Lupane Ward 1	Goat Improvement Center (GIC)	Mr K. Ncube (GIC Committee member) Mr M. Nhlabangani (Business Dev Officer) Ms T. Sibindi (GIC Committee member) Ms Rose Sibanda (GIC Vice Chair) Mr S. Muchadenyika (Agric Extension Officer)	05/08/21
BEST – Mathambo CBC - Lupane	Cattle Business Center (CBC)	Mr Michael Ngwenya (CBC Committee Chair) Mr Phibion Ngwenya (Local Councillor) Mr Shine Tshuma (CBC Secretary) Mr Khoweni Ngwenya (Headman)	05/08/21
TranZ-DVC – Claremont, Bulawayo	Solar power system for milk cooling and lighting.	Mr Albert Ncube & Mrs A. Ncube (Dairy farmer)	06/08/21
TranZ-DVC – Nharira Lanchashire Dairy Association	Fixed Dome Biogas Digester (Done with SNV support in 2014). Solar powered milk cooling & processing centre and borehole water pumping.	Ms E. Marwa (Association Chair) Mr B. Moyo (Secretary) Ms E Dhoro (Committee member) Mr P. Madziire (Committee member) Mr T. Madyangove (Farmer)	11/08/21
TranZ-DVC – Goshen MCC, Rusitu Small Scale Dairy Coop, Chipinge.	Solar powered cooling tank. Solar powered water system (Done with SNV support in 2016).	Ms A. Moyo (MCC chairlady) Mr Z. Mutengu (Dairy Scheme Advisor) Mr R. Chikuni (Rusitu Small Scale Dairy Coop Coordinator)	12/08/21
TrannZ-DVC – Mayfield MCC, Rusitu SSD Coop.	Battery powered tricycles.	Mr R. Chikuni (Rusitu Small Scale Dairy Coop Coordinator) Mr Dumisani Maphosa (RSSDC Book-keper)	12/08/21
TranZ-DVC – Tsonzo	Solar powered borehole.	Mr Washington Sagonda (Farmer & chair of Tsonzo MCC	13/08/21
VALUE – Murehwa W8	Piggery waste management.	Mr Takudzwa Makwengura (Piggery Farmer)	16/08/21
VALUE – Murehwa W24	Bio-digester	Mr Rodney Musara (Piggery Farmer .. interviewed at Murehwa centre ... site not reached)	16/08/21

Annex 5.3 – People Consulted

Organisation	People consulted	Venue	Date(s)
WE-**TranZ-DVC** project	Jacob Mumpande	Skype	20/07/21
WVI – **BEST** project	Gift Chomuzinda Clive Garahushoma	Zoom	20/07/21
FAO - **SAFE** project	Basil Mugweni	Skype	20/07/21
ActionAid – **VALUE** project	Newton Chari Newton Mutara	Zoom	20/07/21
WWH – **IPVC** project	Joseph Matiza Joyline Mutasa Englebert Dzimbanhete Marco Baldi	Zoom	21/07/21
WWH **- ZAKIS** project	Waddilove Sansole	Skype	21/07/21
WVI – **BEST** project	Willard Munangi	On road from Nyamandlovu to Bulawayo	03/08/21
AGRITEX	Ms Soku Dube (DAEO – Lupane)	Lupane AGRITEX Office	05/08/21
AGRITEX	Ms Gertrude Ndege (DAEO – Murehwa)	Murehwa – on road to and during farmer visits.	16/08/21
Mobility for Africa	Ms Fadzai Mavhuna	Tele-conversation	30/08/21

Annex 5.4 Images and brief descriptions of green technologies implemented by ZAGP projects

As indicated in the body of the main report, ZAGP's IPVC project has invested most in studying different green technologies being implemented by the project. In collaboration with University of Genoa a green technologies scoping study was conducted in November – December 2019. One of the deliverables, Deliverable n.1, provides a detailed analysis of all the technologies that have been chosen to empower the poultry value chain in the context of the IPVC project. Deliverable n.1 report gives technical details regarding design, functioning and operating conditions of different green technologies being implemented by IPVC which is the full spectrum of hardware type technologies being implemented by ZAGP projects. This Annex does not discuss the technical details of green technologies and refers those interested in such to the aforementioned Deliverable n.1 report by the University of Genoa.

5.4.1 Battery powered tricycles

The tricycles are battery powered and are environmentally friendly compared fossil fuels, such as petrol and diesel, that have a polluting effect and are not renewable. The batteries are rechargeable using electricity and / or solar power. The technology has potentially no adverse footprint on the environment. It is also user friendly, especially for female farmers.

(a) (b)

Ms Furusiya Manduna is a poultry farmer and Domboshava Group 1 leader. The group of five was assisted with a US$2,400 tricycle by IPVC with Mobility for Africa procuring and supplying the tricycles from China. Picture (a) depicts Ms Furusiya Manduna driving the tricycles at her homestead, and (b) Ms Manduna and Ms Susan Mujati, Agritex Extension Supervisor, showing the tricycle battery housing underneath the bike's carrier. Under the IPVC project, the tricycles are meant to assist farmers move their produce, eggs, to market and ferry farm inputs. According to Ms Melody Zvekure, Domboshava Group 3 leader, the tricycle given to her group has helped reduce transport costs of their poultry businesses. Before the tricycles she claims was paying US$4.00 for transport for five bags of poultry feed that would last her only three days and US$10 to carry grass for chicken bedding. She now relies on the tricycle with a cost of US$1.00 for battery recharge which roughly covers either transporting feed or grass for chicken bedding. It is noteworthy that issues of general repairs and maintenance costs had not arisen as the tricycles were a recent introduction.

Rusitu Small Scale Dairy Cooperative Society was given four battery powered tricycles under the TranZ-DVC, again with Mobility for Africa procuring and supplying. A fourth tricycle was given to another MCC in Chipinge district. The tricycles are on trial.

(c)

(d)

Picture (c) depicts two of the three tricycles at Rusitu Small Scale dairy Cooperative Society, and (d) one of the modes of transport, donkeys, the tricycles are meant to replace. The picture of donkey carrying two milk cans was shot at Goshen MCC, Rusitu, as it arrived from delivering milk at Upperand MCC, which is about 5 km away and up a mountain, on 12 August 2021. Goshen MCC's solar powered 500 litre cooling tank procured for €3,550 under the TranZ-DVC' MGF was awaiting installation at the time of site visit, hence milk was being moved to Upperand MCC where there is a cooling tank.

5.4.2 Bio-digesters

Biogas is the results of the natural degradation of organic matter taking place inside a bio-digester. The process subjects material such as cow dung or slurry from chicken or piggery to microbial decomposition in the absence of air, yielding finally, methane, carbon dioxide and water inside a bio-digester. A condensation process separates the water from the methane with the latter going into a biogas storage from where it is can be directed to burners for domestic heating, heating chicken houses, firing biogas stoves for cooking or firing gas refrigerators for cooling. The digestate (liquid residue) is directed to a reservoir for use as fertiliser. Bio-digesters are a source of clean renewable energy and also an environmentally friendly waste management system. All ZAGP projects, except SAFE and ZAKIS, are implementing bio-digesters which come as fixed dome or tubular bio-digesters.

(a)

(b)

(c)

Pictures (a) and (b) show Mr T. Madyangove a dairy farmer and member of the Nharira Lanchashire Dairy Association pointing out the different parts of his 6m^3 fixed dome bio-digester. The bio-digester is fed with cow dung from the dairy enterprise. Picture (c) shows

the pit where the digestate collects and is fed to a garden (green patch in background) as fertiliser. The unit cost US$1,500 with about a quarter of that funded by TranZ-DVC's MGF.

(a)

(b)

Picture (a) above is a demonstration 6m^3 fixed dome digester at Mr Ndabezinle Nkomo's homestead in Umguza district. Establishment of the bio-digester cost US$1,200 with funding support by BEST and farmer, with help from community, contributing local materials and labour. The bio-digester is feed with cow dung. Picture (b) a youth in Mr Mkomo's household demonstrates switching on a gas stove and a gas lamp fed with gas from the digester.

IPVC supported a demonstration 20m^3 tubular bio-digester, with below pictures, at Mr Joseph Chinyangare's farm in Ward 14, Chegutu district at a total cost of about US$6K.

(a)

(b)

Picture (a) above shows the tubular bio-digester with the digestate storage tank in the foreground at Mr Chinyangare's farm. The digester is fed from pig slurry. Picture (b) shows Mr Chinyangare holding a gas burner heating his chicken house.

5.4.3 Photovoltaic systems

The solar power system uses photovoltaic panels to absorb the light from the sun and converts that into electric energy which can be stored in electrochemical batteries. This technology can be used to power equipment like egg incubators, refrigerators and freezers, common lighting system and other domestic appliances like televisions and radios. The images below are for a system installed for lighting at Mr Tafadzva Charumbira's poultry farm in Goromonzi district, Harare cluster.

(b)

(b)

(c)

Mr Tafadzva Charumbira's photovoltaic system. Mr Charumbira is a poultry farmer and chairperson of the Goromonzi district PBA. He was assisted with a grant of US$5,150 by IPVC for a complete 5 KVA solar system including installation and wiring. Picture (a) depicts the photovoltaic panels mounted on the roof of his house (b) the inventor, battery pack, and control instruments installed in his lounge for security and safety against weather elements, and (c) the inside of the brooder where the lighting is powered by the solar system.

Mr Charumbira was using charcoal in drums for pre-heating the brooder in preparation for receiving 500 day old chicks. The charcoal, he said, is expensive, costing US$10 per 35kg bag and he would need 40×35kg bags from pre-heating to finish involving a batch of 500 birds. Before the solar system was installed he was paying between $200 and $300 for electricity per batch depending on the number of birds which vary between 3.5K and 8.5K per batch. After the installation of the solar power system, his electricity bill reduced to about $40 spent on lighting and powering a borehole. The solar power is used for lighting the chicken runs, cooling (i.e. running the freezers) and other domestic use.

5.4.4 Rocket stoves

A rocket stove is a device for biomass burning producing heat for heating chicken houses. IPVC financed the installation of a demonstration rocket stove at Mr Ntaa Khumalo's poultry farm in Ntabazinduna, Bulawayo cluster in April 2021. The technology was installed at a cost of about US$1,100. The rocket stove is fed with pieces of firewood for burning. Mr Khumalo estimates that the stove uses between a third and a quarter of firewood that the drum system, used by most StM poultry farmers, would consume in heating chicken houses. Mr Khumalo experienced challenges with the original design of the rocket stove and used his engineering background to adapt the technology and produce a modified version.



(a) (b) (c)

Picture (a) shows Mr Khumalo standing by the firewood chamber of the original rocket stove installed at his farm. Picture (b) shows the tube through which the hot air is carried and heat released in the chicken house. Picture (3) shows Mr Khumalo holding the stand on which a solar panel is mounted that was meant to power the rocket stove fan. He has done some modifications to the fan and firewood chamber to make it more effective and efficient. Building on his experience with the original design, he has produced a modified version of the rocket stove that he said is more user friendly, effective and efficient. The modified version is shown in images below.


(d) (e)

These two pictures show parts of the modified rocket stove build by Mr Ntaa Khumalo to improve on the original design. The modified rocket stove cost him about US$700 using scrap material and he reckoned it can be replicated at a cost of no more than US$950 using purchased materials. Picture (a) shows the heated air flow pipe while (b) shows firewood chamber that does not require a fan to push the heated air through pipe in (a). This modified rocket stove is on a chicken house next to the one with the original rocket stove, which original stove he has done some modifications to.

5.4.5 Solar powered incubators

The solar powered incubators are egg hatching facilities or devices powered by electricity or solar power from photovoltaic panels through an inventor and stored in electrochemical batteries. Incubators have advantages over natural hatching as they improve productivity of the birds as hens quickly return to laying and not needing to spend time brooding eggs. IPVC has supported demonstration solar powered incubators with groups of farmers and also funded the installation of one at Matopos Research Institute.


(a)


(b)


(c)

Picture (a) shows photovoltaic panels on roof of Ms F. Moyo's farm storeroom in Umguza district, Bulawayo cluster. Picture (b) shows Ms Moyo standing by the solar powered incubator she shares with other group members. And (c) shows a solar powered incubator at Matopos Research Institute. The incubators have a capacity of 500 eggs each. Ms Moyo's incubator was being powered by electricity as the solar system had blown up and she was awaiting project and installer to address the issue as she claimed system to be still under guarantee. The incubator at Matopos was working but said not to be achieving a certain required humidity level reading. The institute was engaging the project and installer on the issue.

5.4.6 Solar powered water systems

All ZAGP projects, except SAFE, are supporting solar powered water systems. A few examples of solar powered water conveyance systems were captured on camera during project site visits and these are shown in images below.


(a)


(b)


(c)

Picture (a) shows photovoltaic panels on stand (background) that power a borehole pump supplying the 5K litre tank (foreground) at Mathambo CBC, Lupane district. The solar powered water system, tank and pipes were funded by BEST. Picture (b) shows a solar power system for pumping water at Mr Washington Sagonda's dairy farm, in Tsonzo, Mutasa district. The water is pumped into the 90K litre storage tank from where it will flow by gravity irrigating a two hectare fodder plot. Borehole drilling and solar pump fitting were funded under the TranZ-DVC's matching grant facility.

(a)

(b)

Picture (a) above shows Mr Dingilizwe Ndlovu, a goat farmer in Ward 1, Lupane district standing by the portable solar panel and water pump funded under VALUE's matching grant facility. He uses the pump to draw water from a three meter deep well, shown in Picture (b), to a 5K litre tank some 300m away at his homestead where he and his wife, Ms Dorcas Zhikali, water their goats and a fodder garden,

5.4.7 Sawdust pellet making machine or plant

The sawdust pelleting plant is in the plans of IPVC. It has not been installed and hence non was visited for this assignment and there are, therefore, no images. IPVC will be supporting Mutare PBA establish the plant. The objective would be to manufacture pellets or briquettes from sawdust for combustion in place of firewood or charcoal for heating brooders or chicken houses. Sawdust pellets or briquettes are known to be more combustion efficient than firewood. The plan is to use sawdust pellets in rocket stoves. As sawdust is a waste from timber factories the use from pellets manufactured from it will reduce the reliance on firewood and charcoal by poultry producers.