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FACILITATOR'S GUIDE

Supporting Best Practices at Artisanal Gold Mines Toolkit

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MODULE 1:
INTRODUCTION AND GUIDE FOR FACILITATOR

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Introduction and Overview

Goals

IMPACT has spent many years working directly with artisanal mining communities to improve practices, support equitable development, and ultimately help set miners on the path towards formalization and legal trade. In our experience, we've seen that while there are many materials about artisanal gold mining, training resources often aren't accessible to miners themselves. At the same time, the market has high expectations of artisanal miners but provides little support to explain what those expectations are or how to reach them.

The Supporting Best Practices at Artisanal Gold Mines Toolkit aims to fill this gap. This Toolkit has been developed based on IMPACT's work with artisanal gold mining communities to support local actors to improve their capacity on issues that affect their health, safety, and livelihoods. It aims to support users to understand risks within the sector and take safety precautions, while increasing production of artisanal gold in an effective, safe, and environmentally sensitive manner.

While seven initial topics have been identified, IMPACT anticipates adding additional training modules in the future and expanding the reference materials available.

Audience

The users of the Toolkit will be primarily artisanal miners themselves including women. The users will already have a basic knowledge of artisanal gold mining, but the information provided in the Toolkit will deepen their knowledge on specific techniques which will help increase their production in a safe and secure manner, while protecting the environment.

The Toolkit is also appropriate for different stakeholders at the mine site including mine site leadership, organizations such as associations, cooperatives, or informal mining groups, or state services which are tasked with providing support to the artisanal mining sector.

While the Toolkit has been created based on experiences in IMPACT's work, it is not country specific and adaptable across country contexts.

The Toolkit has been designed for trainings in communities with low literacy rates. While the user of the Toolkit will require English or French, they are guided to introduce the training topics to the mining communities using visualizations, hands-on activities, and group discussions.

Toolkit Components

In the Toolkit, each training module is divided into sections which include:

- Facilitators guide
- Group exercises
- Reference materials
- Accompanying visuals

Conducting a Training Session

IMPACT suggests having a trainer with knowledge on artisanal gold mining use the Toolkit to deliver the training to a small group of miners or community members.

TIPS TO KEEP IN MIND

- You can decide to do a training session on however many modules you want and in the order preferred.
- Provide enough time for each module to ensure material is understood by participants rather than rushing through too much information.
- Modules can be broken up into smaller sections for shorter training sessions if desired.
- Provide daycare options for women so that they may fully focus on the training.
- Choose a time that doesn't interfere with work.
- Select the location of your training based on the group exercises required, for example some training sessions may be suitable for a classroom or meeting, while some that require hands-on demonstrations may require a mine site.

Always ensure to adapt the training materials to the context and participants as needed. For example, if training a group of mine site leaders their learning needs may be different than miners. Use examples that are specific to the local context and that the participants can relate to.

NOTE TO THE FACILITATOR

Instructions for the facilitator are provided in grey text boxes, indicating instructions or activities.

Suggestions are made in each section regarding facilitation. It is up to the person in charge of training to adapt them to the context and circumstances or to even adopt more appropriate learning approaches.

Depending on the context, illustrations can be used in a variety of ways. They can be photocopied and distributed to participants, projected on a screen, or shared as laminated posters.

The reference files include videos, brochures or posters. These can be screened, projected, left with the miners as learning aids, or shared in the community and mine site.

Particularities of Adult Training

Adult training is distinguished by a few elements, including the following:

- Training should only be done once the training needs have been identified. Trainees will only want to learn what they need.
- The role of trainer is to facilitate learning.
- Participants should be encouraged to share their knowledge and experiences from their day-to-day lives to make the training session more accessible.
- The facilitation for the training sessions and exercises should be adapted to the participants and their specific context.

We encourage the person who is facilitating the training to:

- Complete a train-the-trainer training
- Have experience in the artisanal gold sector
- Prepare and adapt the training to their participants

A Note on Terminology

Language on mining and the artisanal gold sector varies across contexts. This is especially true when discussing countries that have a more informal sector versus those already on the path towards formalization.

The Toolkit aims to use general terminology for it to be applicable across different contexts. For example, the term "mining group" is used to describe both informal and more formal groups such as associations or cooperatives. It is up to the facilitator to adapt the terminology based on the context and participants, to ensure the training reflects their reality.

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IMPACT transforms how natural resources are managed in areas where security and human rights are at risk. We investigate and develop approaches for natural resources to improve security, development, and equality. We are an independent non-profit, collaborating with local partners for lasting change.
www.impacttransform.org

The **planetGOLD Uganda** project aims to reduce the use of mercury by supporting formalization of the artisanal gold mining sector and increasing access to finance. This will lead to adoption of mercury-free technologies and allow access to more responsible and traceable gold supply chains. The project is supported by the Global Environment Facility, led by the UN Environment Programme, executed by IMPACT in partnership with Uganda's National Environment Management Authority and the country's Ministry of Energy and Mineral Development under the Department of Mines.
www.planetgold.org/uganda

The **planetGOLD Côte d'Ivoire** project aims to reduce the use of mercury in the artisanal gold mining sector through a holistic, multi-sectoral and integrated formalization approach. The project also aims to improve access to traceable gold supply chains and financing for the adoption of sustainable, effective and practical mercury-free technologies. The project is supported by the Global Environment Facility, led by the UN Environment Programme, executed by the Centre Africain pour la Santé Environnementale (CASE) and IMPACT.
www.planetgold.org/cote-divoire

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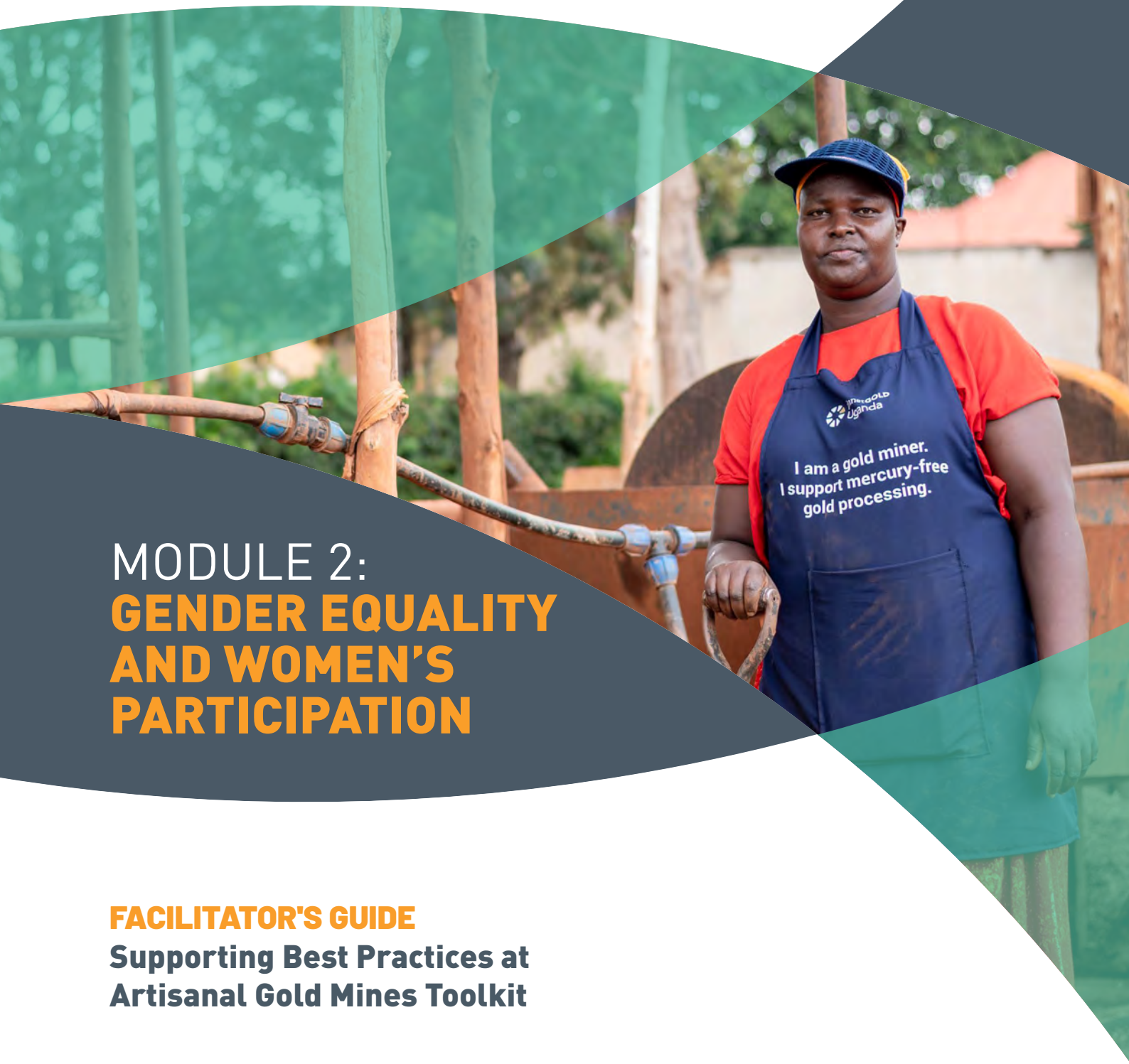

MODULE 2:
GENDER EQUALITY AND WOMEN'S PARTICIPATION

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Learning Outcomes

BY THE END OF THIS SESSION, PARTICIPANTS SHOULD:

- Understand the types of activities women do in mining
- Understand the barriers women face in mining
- Understand rights of women in the mining sector
- Understand various risks and violations women face
- Identify strategies to improve women's participation in the sector
- Identify strategies to increase women's leadership

NOTE TO THE FACILITATOR

This training can be completed in a classroom or meeting room setting. Activities are focused on discussion questions. Hands-on learning is suggested when possible and appropriate.

Gender Roles in Artisanal Gold Supply Chains

Women and men engage in the artisanal gold sector to earn incomes and support their livelihoods. There are many different activities across the supply chain, with both women and men found in each activity. However, women often face several barriers in fully participating at the mine site.

These barriers include:

- Cultural and social norms or perceptions
- Lack of finance
- Lack of training or knowledge on mining techniques
- Men reserving the most profitable roles for themselves
- Lack of decision-making power or participation in the governance structure
- Lack of representation
- Lack of adequate sanitation facilities
- Lack of access to equipment, ore, or even areas of the mine site
- Only men being able to sell gold

Image 1 : Different barriers women face at the mine site.

NOTE TO THE FACILITATOR

Ahead of the training, the trainer should research and become informed about the role of women in the mine site and commonly held perceptions, which may vary across the region.

Activities in the Supply Chain

PROSPECTING

- Searching for mineral deposits by identifying rocks or outcrops
- Geological mapping
- Sampling rocks and soils
- Digging pits and trenches to identify bodies of ore
- Applying for prospecting permits and agreements with landowners
- Providing water for sampling and food for prospecting workers
- Use of equipment such as GPS and other geological tools
- Manual processing to ascertain mineralization

During prospecting women can fully participate in all the activities, but they are often relegated to providing water and food to prospectors. Due to a high level of expertise required in knowing about rocks and geological mapping, prospecting tends to have few women involved since local knowledge is passed on by men to men, not usually to women. However, since prospecting is a key and essential stage in artisanal gold mining, women should seize every opportunity to engage more actively and benefit from the status and advantages of prospecting.

Image 2 : Women in prospecting.

MINING

- Digging and excavating pits, tunnels, and shafts
- Use of equipment to excavate the ground
- Drilling and handling of ore and waste rock
- Haulage of ore from the pit to surface and processing area
- Provision of equipment such as water pumps, generators, drilling equipment, and personal protective equipment
- Use of ladders, winches, and mine support
- Compliance with regulatory requirements on mining

Women can participate in mining activities and in many regions work as diggers, go into pits or tunnels, or use equipment such as drills. They also transport sacks of ore, just like their male counterparts. However, for many, this is a highly profitable sector of the supply chain from which women have been generally excluded due to cultural beliefs and norms limiting their full participation, perceptions of women's weakness, and poor sanitary conditions at mine sites. Women transport ore from the pit to the surface just like men but are paid less. Despite the constraints, women have demonstrated that they can also earn a living as shaft or pit owners, supplying equipment, and supervising other workers.

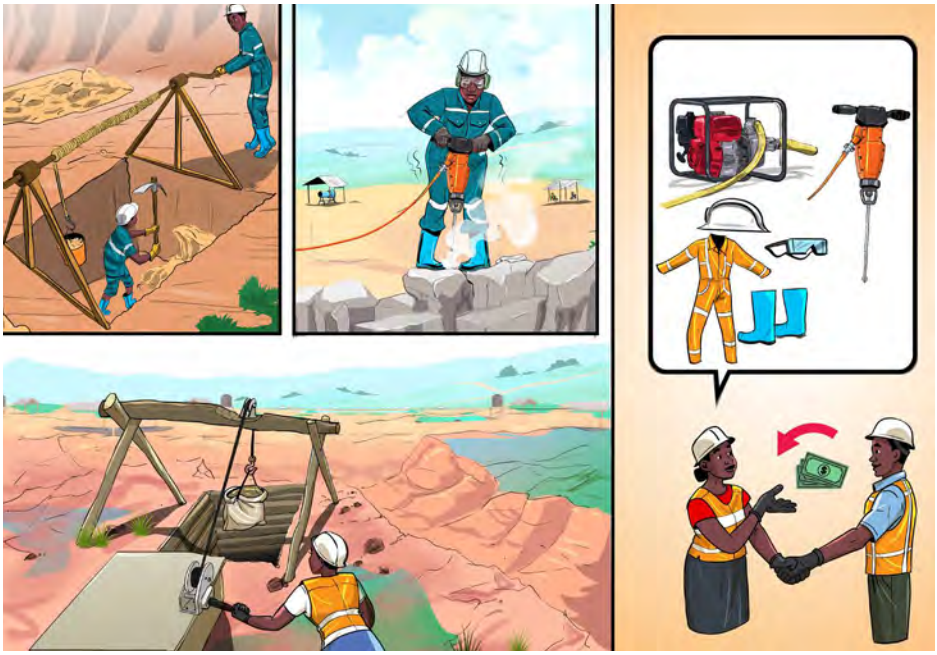

Image 3 : Women in mining.

MINERAL PROCESSING

- Transporting ore
- Crushing
- Screening
- Sluicing and panning
- Supplying processing water
- Working with processing equipment
- Owning processing equipment

Women are very active in this area of the supply chain and are often found carrying out all of these activities, but they are often paid less than men for carrying out the same tasks. Women also have less access that men to improved manual and motorized mining tools and training, such as sluices with newer-model mats. However, in some regions, women own the processing equipment, such as mills, for which they receive service fees from users.

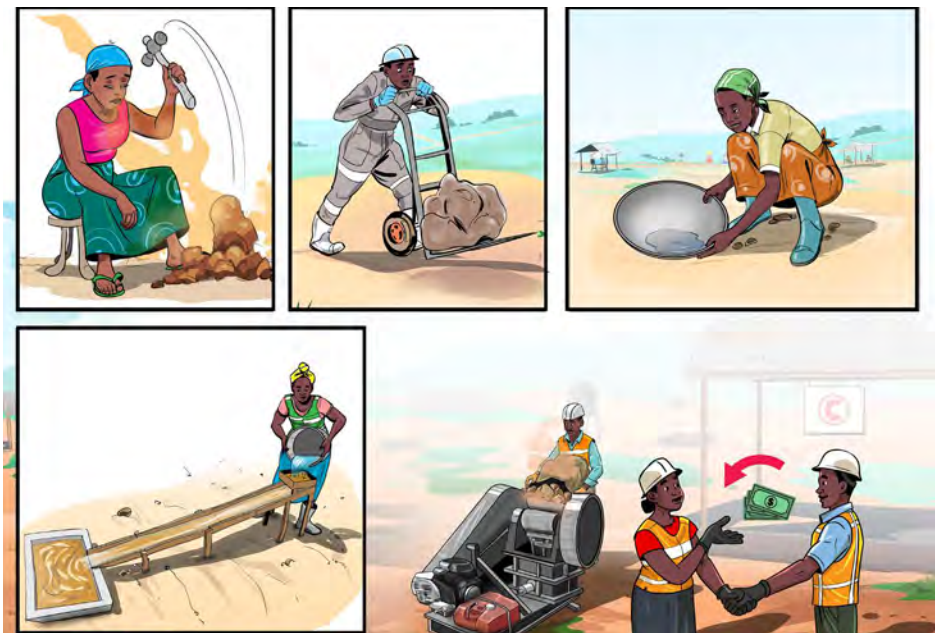

Image 4 : Women in mineral processing.

TAILINGS MANAGEMENT

- Reprocessing tailings
- Buying and selling tailings
- Transporting of tailings to leaching sites
- Scavenging from tailings

Women are involved in these activities in various ways. The major role of women includes re-working tailings as scavengers before they are reprocessed or discarded as waste. Some women with financial resources are involved in leaching gold tailings and trading tailings for profit. This is an area dominated by men due to the need to have cash to purchase tailings and requirement of chemicals for reprocessing the tailings. Few women work as chemists or technicians in tailings leaching facilities due to limited technical skills. This is an area where women can increase their mineral processing and metallurgical skills to gain additional opportunities in the sector.

Image 5 : Women in tailings management.

GOLD RECOVERY AND TRADE

- Amalgamation and burning of amalgam to recover gold
- Use of retorts and smelters
- Supplying mercury
- Gold trading
- Pre-financing of mining activities

Women are involved in the different activities, mostly in amalgamation and gold buying. In amalgamation, few women are aware of the harmful effects of the mercury frequently used in gold mining on their health and the environment. Those with financial capacity engage in prefinancing mining operations. They most often get paid in gold.

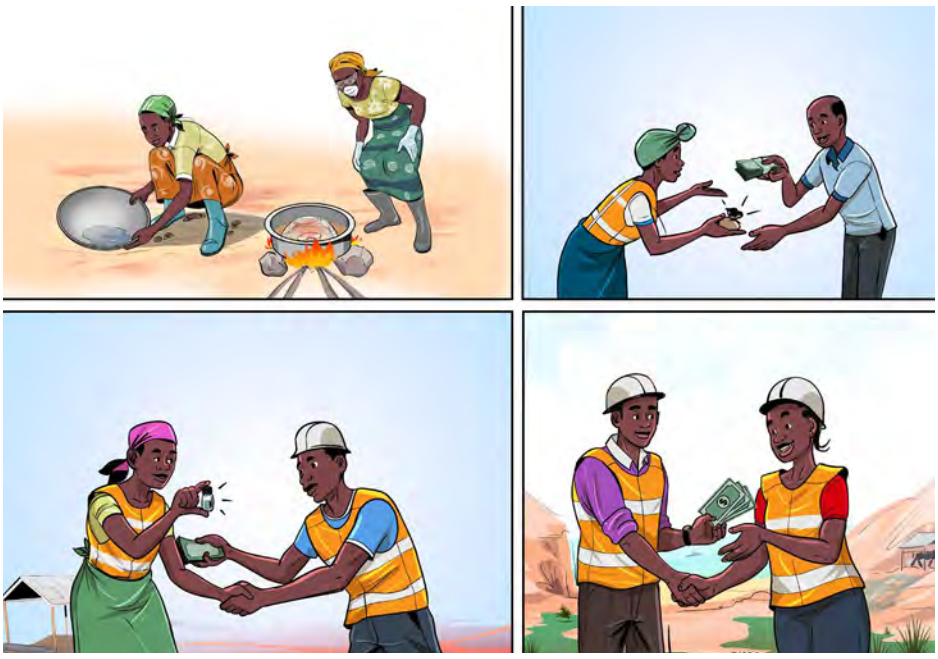

Image 6 : Women in gold recovery and trade.

OTHER ROLES AT A MINE SITE

Women are also involved in providing services at mining sites. They provide water for processing, meals for miners, and trade in various goods such as food and household items. It is important for women to be involved in the different parts of the mining supply chain. This allows them to have access to natural resources, earn better incomes, and participate in mining leadership roles.

Image 7 : Women in other roles at the mine site.

ACTIVITY

As a group, discuss the following questions:

1. What activities do you and other women at the mine site participate in most frequently?

2. Are there any obstacles for you to participate in other activities across the supply chain?

3. Think of the five supply chain activities (prospecting, mining, mineral processing, tailings management, and gold recovery and trade). Who are the most prevalent people in each activity (women and men)? Why?

4. In the activities where women's participation is low, how can it be increased?

Rights of Women

Women have the same rights in the mining sector as men. These rights are enshrined in a country's constitution, mining laws, and other national legislation and international laws that your country has ratified.

There are cultural and social norms that restrict women's rights, but these restrictions are not legal.

NOTE TO THE FACILITATOR

Ahead of the training, the trainer should research and become informed about the rights of women applicable to artisanal and small-scale mining in the community. This section can be adapted to introduce key points from the local regulations.

Women should understand and exercise the following rights within the mining sector:

- Right to access mineral resources and engage in mining
- Right to a safe working environment
- Right to non-violence
- Right to non-gender-based discrimination
- Right to engage in an economic activity and gain income for livelihood
- Right of association with others to form groups advancing common interests
- Right to clean drinking water and sanitation

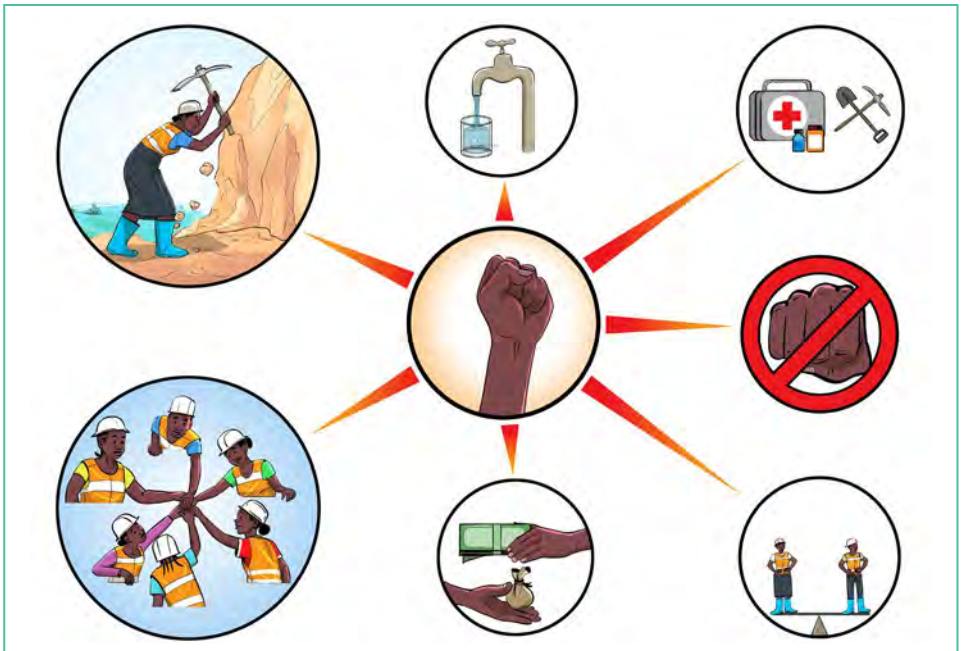

Image 8 : Rights of women in the mining sector.

LEGAL KNOWLEDGE

Knowledge of what the law says is critical to empower women to participate effectively in mining. Women have roles in mining and should have access to land, the right to mine and the means of production such as equipment. Women can apply to register for a mining permit and run their own mine. There are many examples of women in other countries who have broken the glass ceiling, and they lead successful mining operations or mining groups of women miners.

Image 9 : Women can register for a mining permit and run their own mine.

TECHNICAL KNOWLEDGE

Mining is informed by geological information of ore deposits and mineralization. It is also done in a largely dangerous environment with many risks. Women need to have technical knowledge to optimize mining operations and implement safety and security controls.

These include knowledge of:

- Identifying areas of gold ore
- Mineral processing to improve recovery of minerals
- Safety rules and requirements
- Safe handling of dangerous chemicals such as mercury
- Use of personal protective equipment such as gloves, boots, safety glasses, masks
- General management of mining operations

Women can aspire to undertake training and increase their knowledge on mining. Knowledge opens doors to opportunities, improves productivity, and increases safety in mining operations.

Image 10 : Women can aspire to undertake training and increase their knowledge on mining.

ACCESS TO, USE AND CONTROL OVER LAND AND PRODUCTIVE RESOURCES

Women face many challenges with access to resources. These barriers could be cultural, social and have been accepted as normal. These barriers have kept women exposed to poverty and the burden of hard work to make ends meet for their families. Women must be able to own land, apply for mining rights, own equipment, and make decisions on their economic choices. Women should decide what roles in mining they want to take on, instead of being pushed to the less profitable roles due to norms in their communities. Women should earn the same money just like men do and should be free to sell their gold and manage their income.

Image 11 : Women should earn the same money as men.

ACTIVITY

As a group, discuss the following questions:

1. Do you know your rights at the mine site?

2. Do you know your rights regarding owning land?

3. Can you easily apply for a mining permit? Why or why not?

4. What are challenges in accessing legal knowledge?
   Where are some of your knowledge gaps?

5. What are the barriers for women to access resources in mining?

6. What can be done to address these barriers?

Human Rights Violations Faced by Women at Mine Sites

Women involved in mining face different types of risks. A risk is the possibility of something happening that will have a negative impact.

ECONOMIC RISKS

Women often do not have access to the best resources at a mining site. They do not have access to the rich deposits, but usually work on tailings or what male miners have left over. In addition, they don't have the technical skills and equipment to engage in safe and productive mining. As a result, they spend most of their time with minimal mineral recoveries. When women recover gold, sometimes it may be taken away by their husbands. They may be denied their hard-earned income, or they get cheated by gold buyers as they don't have access to their own scales or knowledge about the price of gold or its quality.

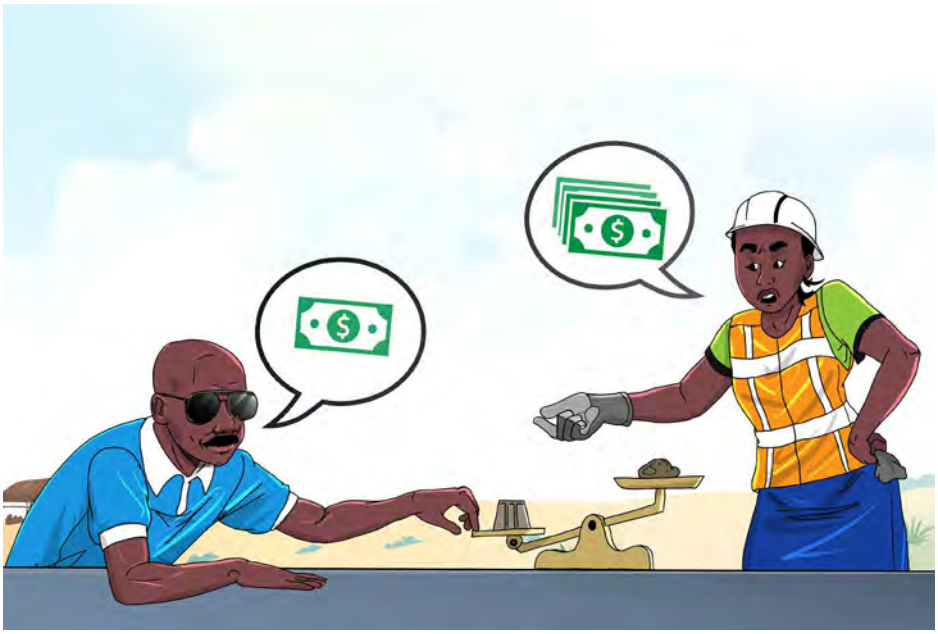

Image 12 : Women face economic risks working in the mining sector.

HEALTH RISKS

Working in the mine site exposes women to several health risks including respiratory diseases due to dust, chronic back pain, miscarriages due to hard labour, poor sanitation or toilet facilities, and sexually transmitted diseases. In addition, women are often working with hazardous chemicals such as mercury, which harms unborn children and has a long-term impact in child development.

Image 13 : Women face health risks working in the mining sector.

PHYSICAL VIOLENCE

Physical violence are acts that result in pain, discomfort or injury. These may result due to conflict or disagreement on sharing the money with partner, or robbery when women have recovered gold.

Image 14 : Women face physical violence working in the mining sector.

SEXUAL VIOLENCE

Sexual violence is sexual activity without consent. In some contexts, men feel entitled to sexually exploit women on mining sites, asking them for sexual favors. This exposes women, especially the youngest and most vulnerable to risks affecting their health, well-being, and safety. If they refuse, they are deprived of economic opportunities. In some contexts, women and adolescent girls are trafficked to work on sites where they are forced to work, and many end up being sexually abused. This leads to physical and psychological abuse, as well as infectious diseases.

Image 15 : Women face sexual violence working in the mining sector.

ACTIVITY

As a group, discuss the following questions:

1. Do you feel safe when at home? When working? Why or why not?
2. What are some of the economic risks you or women who work in mines may face?
3. What are some of the health risks women at your mine site face? How can they be addressed?
4. Is physical violence against women common at mine sites?
5. What are the usual causes of physical violence?
6. Do women have a support group or other recourse available?
7. Where do they report cases of physical violence?
8. Is sexual violence common at the mine site?

Strategies for Women's Protection and Participation

Strategies need be put in place to support women engaged in mining and advance their opportunities to increase their participation in the sector.

Women have ability to engage in mining activities if they are trained and given the skills and resources such as capital and equipment. They also need to be given access to mining rights and land. This allows them to have access to natural resources, earn better incomes and participate in mining leadership roles.

There are many examples of successful women miners who have become mining leaders, supervising teams, owning mines, and even employing men. These women have made profits and are good examples to other miners, with some of them more skilled at mining than men.

Strategies to support women's protection and participation at the mine site include:

- Encouraging women's participation in the governance structures of mining organizations
- Integrating gender inclusion and women's protection policies in mining organizations
- Solidarity and working as women mining groups
- Receiving technical knowledge and training
- Reporting risks and violence to relevant authorities
- Implementing protective measures to minimize health impacts such as use of Personal Protective Equipment (PPE) and retorts. *(see further Modules for additional details)*

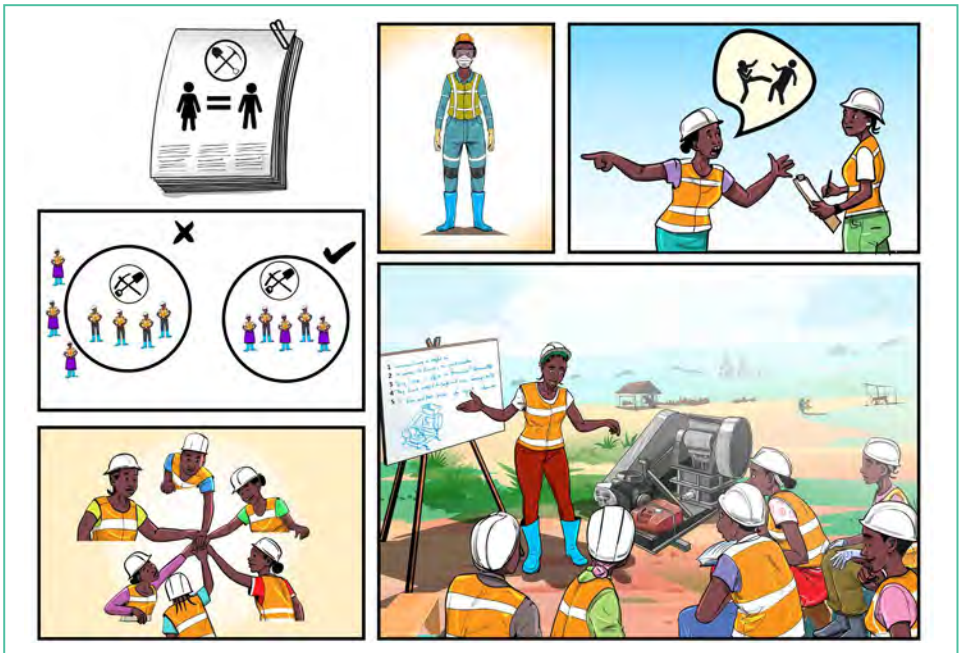

Image 16 : Strategies to support women's protection and participation at the mine site.

HUMAN RIGHTS BASED APPROACH

Human rights are integral to ensuring prosperous and safe mining that can benefit both women and men. Understanding basics on Human Rights Based Approaches empowers women on their position as miners.

The five key elements are:

1. Compliance with national and international laws and conventions: National laws recognize the role of women in society and provide for equal treatment and opportunities.

2. Empowerment: Empowerment through knowledge and information sharing, exposure to technical knowledge and remedial channels. Women can be trained on their rights, legal frameworks on mining, application for mining rights, safety and environment, leadership and business management.

3. Participation: Women should be included in mining association discussions, be part of decision making, and have their views and inputs provided for.

4. Attention to Disadvantaged Groups: Main limitation for women participation in mining include caring for their young children, pregnancy, the gendered division of labor, and general conditions at mine sites.

5. Accountability: Accountability by government and mining group leaders on integrating women into mining activities and protecting them against violations. The mining group should have a focal point to receive complaints from women with regards to unfair treatment and abuses.

IDENTIFYING CHAMPIONS

Champions among men and women can support and promote women working in the mining sector. Champions can be allies to support women to navigate the challenges they face in advancing their interest in mining, provide advice on dealing with the challenges they face, and keep them encouraged to push on.

TRAINING

Women are discriminated and denied access because they may lack knowledge of their rights or skills. By increasing their knowledge and capacity, they can understand their rights and increase their technical skills.

WOMEN FOCAL POINTS WITHIN MINING GROUPS

Mining groups should appoint focal points to represent women and be a point of contact when there are problems women face. The focal points should feel safe and protected to escalate any issues and find solutions. Issues of criminality against women such as sexual violence and physical violence should be reported to relevant authorities.

As part of women protection and empowerment strategy, women can be supported and protected through the following actions:

- Activities and campaigns that encourage women to participate actively in mining. Women in mining should have direct access to the ore rather than having to rummage through what others have left.

- Mining sites should be safe and properly maintained to encourage women's participation.

- Men and women can work together and support each other. Families can work together, or a group of men can support women in mining.

- Creating a safe space for women to ask questions, share their issues in the mines and find solutions for their problems.

- Identify programs in government or development projects that can support women and provide equipment, skills, and business knowledge on mining operations.

ACTIVITY

As a group, discuss the following questions:

1. What are key actions that can be implemented at your mine site to advance women's protection and participation?

2. Are there any women's champions at your site? How can we identify and work with champions?

3. Are women's interests in the mining group addressed? Why or why not? How can they be?

How Women Can Be Leaders at Mining Sites

Women are leaders across our society and different sectors. There are women running schools, businesses, politics, as well as in the mining sector, including traders, mining operators, and leaders of mining groups.

Women's leadership in the artisanal mining sector is possible.

INVESTING RESOURCES IN MINING

Women can come together and put resources to buy mining or processing equipment such as a water pump, compressor or mill for processing. The equipment can be rented to other miners to make additional income. Alternatively, the equipment can be used directly by a women's mining group to improve production and thus profitability.

When one invests in a mining operation regardless of the size of the operation, it gives them a position of influence and leadership.

Image 17 : Women can invest in mining.

TAKING INTEREST IN LEADERSHIP ROLES AND TECHNICAL KNOWLEDGE

Developing mining skills requires interest, learning on the job, having an interest and believing in oneself. Women can be eager to improve their technical skills including how to operate processing equipment and how to prospect for minerals. It may be difficult to have willing teachers as some of the jobs are traditionally seen as men only jobs. Over time women will develop skills and can take up leadership roles.

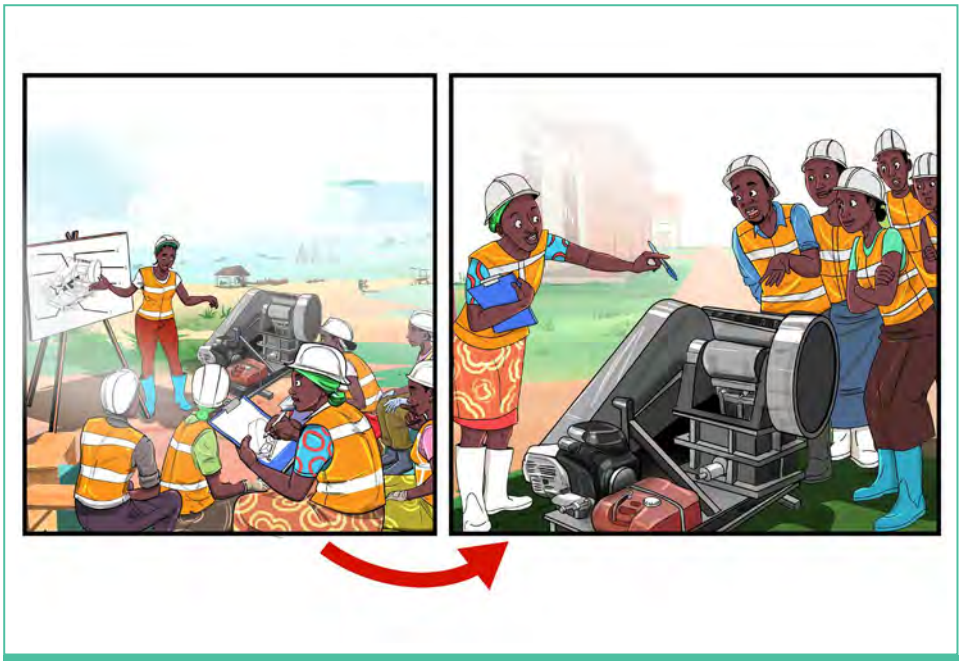

Image 18 : Women can take interest in leadership roles and technical knowledge.

ENCOURAGING AND PLANNING FOR WOMEN TO GET INTO LEADERSHIP ROLES

Mining sites and mining groups can be intentional about facilitating women into leadership roles. A policy can be implemented to have women in specific roles exposing them to leadership opportunities. Women can be appointed to the mining group executive, committees and other relevant roles. Women should be exposed to supervision, planning, as well as managing people and stakeholders on behalf of the mining organization. It is equally important that youth are encouraged to take leadership roles and present their interest within the organizations.

Women have a double burden and responsibilities at home, and this can make it hard for them to take additional roles in mine sites. However, the community can be encouraging and expose women to leadership roles and support them. Women should not think they are less capable but work hard in their leadership roles.

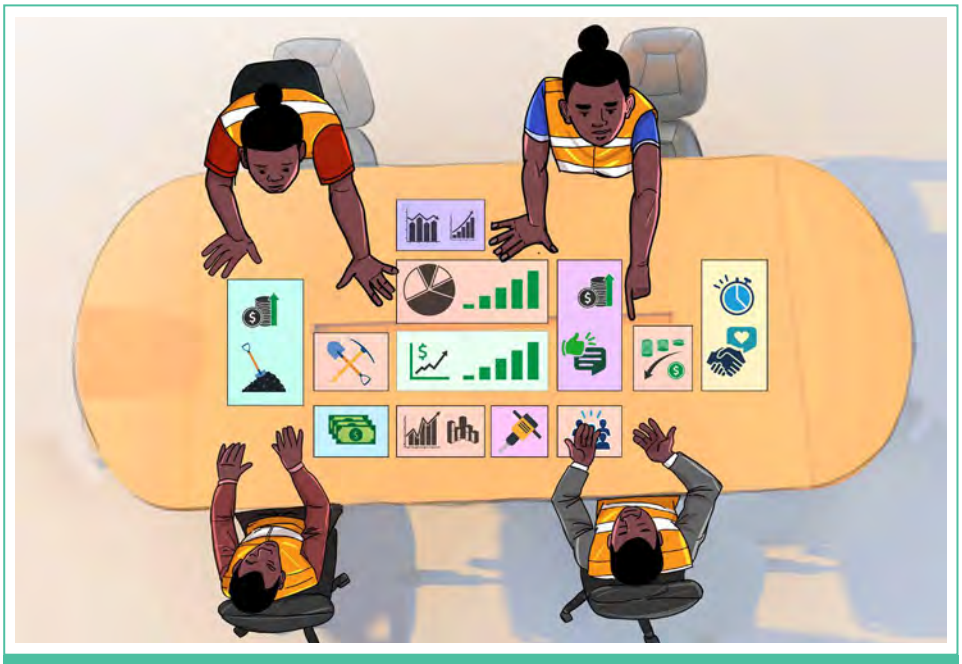

Image 19 : Mining groups can encourage women to get into leadership roles.

FINANCIAL EMPOWERMENT

Women can buy land and equipment in their name and have it legally secured through registration. Women should be able to sign documents with the government and other parties and have the right to register or sign for assets in their individual capacity.

Image 20 : Women can be financially empowered.

IDENTIFY SERVICES THEY ARE GOOD AT AND OFFER THEM TO MINERS

Miners require services to engage in mining. Services include equipment, food, mining inputs, water for processing, accommodation facilities and many others. Women can identify services they can offer.

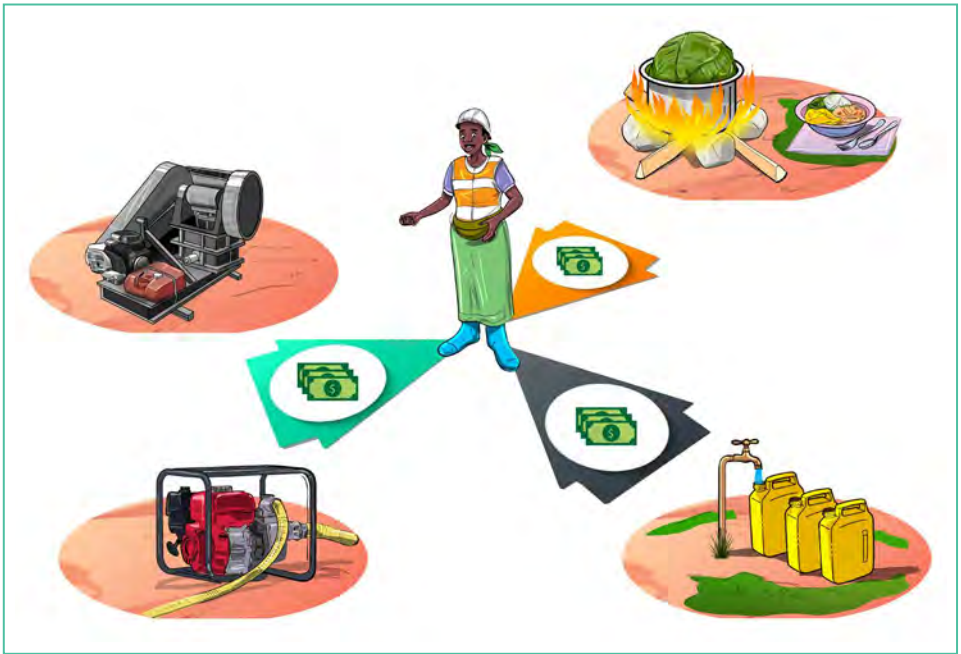

Image 21 : Women can identify services to offer to miners.

ACTIVITY

As a group, discuss the following questions:

1. Looking at your mining area, what services do miners need?
2. Can you identify areas that women can do well and discuss how women can be supported to engage in them?
3. Are there women leaders at your mine site? Why or why not?
4. How can more women be encouraged to take on leadership roles?
5. What are the challenges for women when it comes to investing?

Resources Available

VIDEO:
Equal Rights, Equal Work, Equal Pay
Learn about the rights women have at an artisanal mine site

English : https://bit.ly/IMPACTEqualRights_VideoEN
French : https://bit.ly/IMPACTEqualRights_VideoFR
Baoule : https://bit.ly/IMPACTEqualRights_VideoBaoule
Dioula : https://bit.ly/IMPACTEqualRights_VideoDioula
Djimini : https://bit.ly/IMPACTEqualRights_VideoDjimini
Senoufo : https://bit.ly/IMPACTEqualRights_VideoSenoufo

VIDEO:
Women As Leaders In Artisanal Mining
Learn about how women in artisanal mine sites are working together to have their voice heard.

English : https://bit.ly/IMPACTWomenLeaders_VideoEnglish
French : https://bit.ly/IMPACTWomenLeaders_VideoFR
Baoule : https://bit.ly/IMPACTWomenLeaders_VideoBaoule
Dioula : https://bit.ly/IMPACTWomenLeaders_VideoDioula
Djimini : https://bit.ly/IMPACTWomenLeaders_VideoDjimini
Senoufo : https://bit.ly/IMPACTWomenLeaders_VideoSenoufo

TOOLKIT:
Gender Impact Assessments For Projects And Policies Related To Artisanal And Small-Scale Mining
Use the Gender Impact Assessment Toolkit to ensure ASM-related initiatives meaningfully help women and gender equality.

English : https://bit.ly/GIAToolkitASM
French : https://bit.ly/EIGTrousseEMAPE
Spanish : https://bit.ly/GIAToolkit_Spanish

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www.planetgold.org/uganda

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MODULE 3:
HEALTH AND SAFETY RISKS IN MINE SITES

FACILITATOR'S GUIDE

Supporting Best Practices at Artisanal Gold Mines Toolkit

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Led by UN environment programme

In partnership with Canada

Lead Author: Josephine Singo, Devsol
Contributors: Carmen Teichgraber, Gisèle Eva Côté, Lynn Gitu, and Peninah Asiimwe
Managing Editor: Zuzia Danielski
Illustrations and Graphic Design: Pencil Line Media
Photos: Miléquêm Diarassouba (pgs 1, 2) in Cote d'Ivoire and Media Factory (pg 4) in Uganda

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Learning Outcomes

BY THE END OF THIS SESSION, PARTICIPANTS SHOULD:

- Understand the impact of workplace injury or illness
- Identify health and safety risks associated with mining
- Identify where to receive health care
- Understand the health and safety risks posed to the nearby community

NOTE TO THE FACILITATOR

This module aims to raise awareness about health and safety risks in artisanal mine sites. *Module 4: How to Improve Health and Safety at Mine Sites* provides information on how to address some of these risks to improve health and safety at the mine site.

This training can be completed in a classroom or meeting room setting. Activities are focused on discussion questions. Hands-on learning is suggested when possible and appropriate.

The Impact of Injury and Illness

Artisanal gold miners are exposed to dangerous workplace hazards with limited or no attention to occupational health and safety protection. The sector is associated with persistent hazards such as unsafe mining pits, pit flooding, landslides, chemical use, injuries, noise, dust, overcrowding, as well as poor sanitation and hygiene. Exposure to workplace hazards without proper protection can lead to accidents, injuries, and diseases.

Image 1 : Workplace hazards at mining site.

Workplace injuries can result in loss of income, long-term health issues, and even death. For the mine site, when there is an injury, it can result in loss of time, increased operation costs, or even closure of mining operations.

The impact of a workplace accident at the mine site can include:

- Death due to injury
- Death due to disease or illness if not treated at an early stage
- Injury, disability, and inability to work resulting in loss of income
- Chronic medical conditions such as respiratory and musco-skeletal diseases
- Chemical poisoning
- Health care costs
- Closure of mining operations

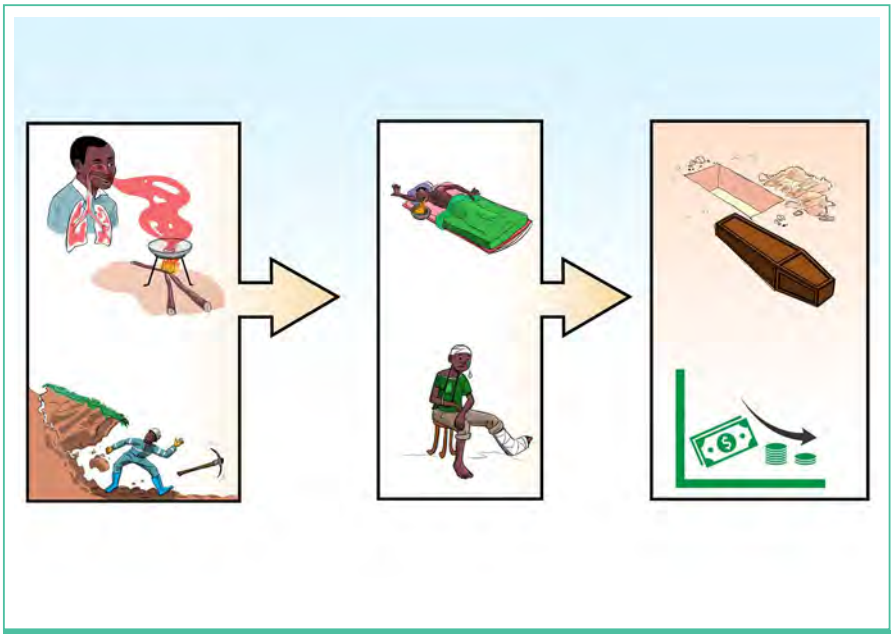

Image 2 : Impact of a workplace accident at mine site.

Artisanal mining occurs in largely informal settings and miners have limited or no technical training. Accidents and injuries are among the major causes of death in artisanal gold mine sites.

Safety and health risks are influenced by many factors which may include:

- Informality and poor compliance with regulatory frameworks
- Poor site organization
- Migratory nature of miners
- Poorly functioning mining group
- Lack of mine site level policies
- Limited resources and equipment
- Limited knowledge and competence on health and safety
- Limited health care and government social support

Image 3 : Factors influencing safety and health risks.

ACTIVITY

As a group, discuss the following questions:

1. Are you concerned about your health and safety when working at your mine site?

2. Why or why not?

Safety Risks in Artisanal Mining

The artisanal gold supply chain consists of different activities, each with their own set of health and safety risks. Miners need to be aware of these different risks to be able to take preventative measures to protect themselves properly.

Most of the health and safety challenges faced by miners cut across the supply chain. This includes exposure to dust, poor sanitation and hygiene, and working in difficult weather conditions without protection.

Image 4 : Different health risks at the mine site.

PROSPECTING

Prospecting involves searching for mineral deposits to identify gold veins and establish mine pits or shafts. It involves identifying rocks or outcrops, geological mapping, digging pits to identify bodies of ore, as well as applying for permits and licenses.

Risks associated with prospecting:

- Unsafe pits that cause collapse, rock falls, mudslide, or landslide
- Pit flooding
- Injuries from tools and equipment
- Exposure to noise, dust, gases and fumes from mechanical equipment
- Exposure to wildlife including snake bites
- Exposure to malaria and other public health diseases
- Poor sanitation and hygiene
- Exposure to difficult weather conditions without proper shelter

Image 5-A : Risks associated with prospecting.

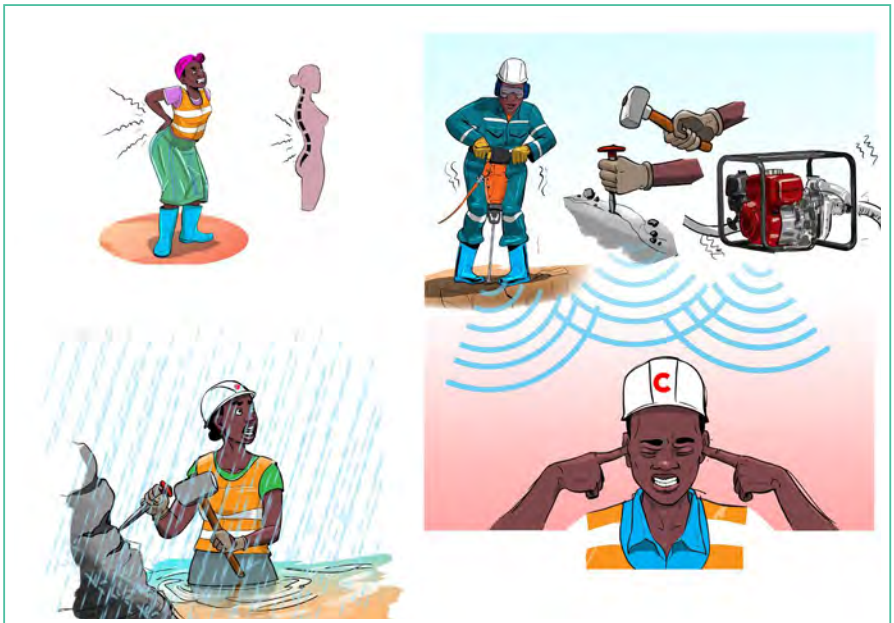

Image 5-B : Risks associated with prospecting.

MINING

Two types of mining are common in the artisanal mining sector. Alluvial mining involves digging near surface gravels to expose gold bearing materials at the bottom. Miners tend to dig narrow shafts and tunnels to access the mineralized layer. Alluvial mining is carried out near or in riverbeds and riverbanks.

Primary mining involves miners accessing the gold deposit from its place of primary occurrence through surface or underground mining methods. The sector is common for surface mining of oxidised, near surface deposits, as well as underground mining through deep shafts to access the gold veins. The veins can be mined from surface following the deposit outcrop. Small shafts are dug into the ground and can extend over tens of meters. Tunnels are added to access the deposit horizontally.

Mining involves digging, breaking the rock, and carrying it for processing. It is the most labour-intensive part of mining and exposes miners to many risks. Risks associated with mining:

- Unsafe pits that cause collapse, rock falls, mudslide, or landslide
- Unsafe safe shafts or openings that aren't properly reinforced, leading to collapse
- Unsafe tunnels that can collapse
- Undercutting rock or soil leading to collapse
- Pit and tunnel flooding
- Lack of adequate oxygen in tunnels
- Injuries from tools and equipment
- Injuries from slips and falls
- Exposure to noise, dust, gases and fumes from mechanical equipment
- Heavy lifting and body pains
- Standing for long hours in water in mining pits
- Exposure to wildlife including snake bites
- Exposure to malaria and other public health diseases
- Respiratory diseases
- Poor sanitation & hygiene
- Exposure to difficult weather conditions without proper shelter

Image 6-A : Risks associated with mining.

Image 6-B : Risks associated with mining.

PROCESSING

This involves the selection, sorting, crushing, screening and milling of ore to liberate the gold. In hard rock mining, the ore is crushed and milled before miners use a sluice and wash to recover gold concentrate, often adding in mercury. For alluvial ore, a screen is used, and the ore is mixed with water and washed on a sluice with mats to recover the gold.

Risks associated with processing:

- Exposure to chemicals including mercury, cyanide, and heavy metals
- Injuries from tools and equipment
- Injuries from slips and falls
- Exposure to noise, dust, gases, and fumes from mechanical equipment
- Heavy lifting and body pains
- Standing for long hours in water in the processing area
- Respiratory diseases
- Poor sanitation and hygiene
- Exposure to difficult weather conditions without proper shelter

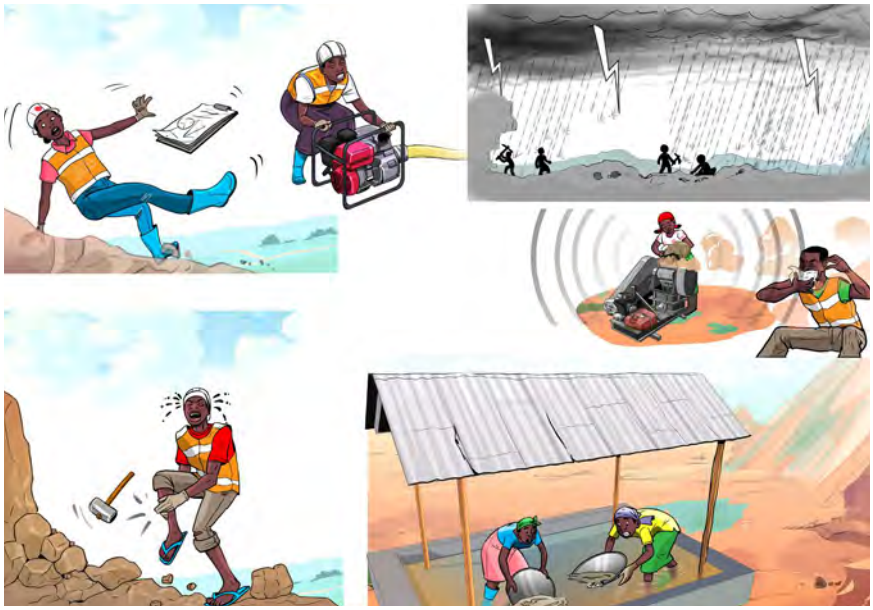

Image 7 : Risks associated with processing.

TAILINGS MANAGEMENT

This involves the management of mining and processing waste, including the reprocessing of tailings. The tailings may contain hazardous chemicals such as mercury from processing and heavy metals which react with water to form acids and other dangerous chemicals. Poor management of tailings contaminate the environment and expose miners and communities to health risks. During the dry season, tailings dumps can be a source of dust containing hazardous chemicals.

Risks associated with tailings management:

- Tailings collapse due to mudslides or landslides during rainy seasons
- Exposure to chemicals including mercury, cyanide, and heavy metals
- Chemicals leaching into the local water sources
- Dust and heavy minerals exposure during dry season

Image 8 : Risks associated with tailings management.

GOLD RECOVERY

This involves use of chemicals such as mercury and cyanide to recover the gold from other minerals within the concentrate or the tailings material. Gold amalgam is burned to remove the mercury with the resulting gold sponge produced for trade. Risks associated with gold recovery:

- Exposure to chemicals including mercury, cyanide, and heavy metals
- Injuries from tools and equipment
- Exposure to noise, dust, gases and fumes from mechanical equipment
- Heavy lifting and musco-skeletal disorders
- Standing and bending for long hours in water in processing
- Exposure to wildlife including snake bites
- Exposure to malaria and other public health diseases
- Respiratory diseases
- Poor sanitation and hygiene
- Exposure to difficult weather conditions without proper shelter

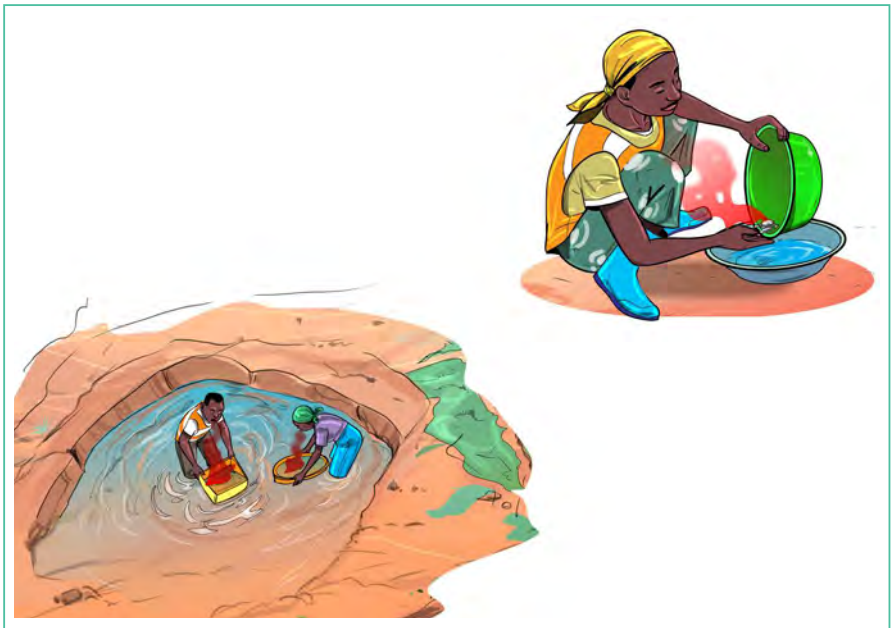

Image 9 : Risks associated with gold recovery.

Risks Related to Equipment Use

Use of equipment such as tools (including hammers, shovels, pickaxes) or machines (including crushers, hammer mills, motor pumps, generators) can cause accidents and injuries. The risk of injury is increased when the equipment isn't maintained and stored properly, and Personal Protective Equipment isn't used. Signs and barriers should be installed to prevent the entry of children and unauthorized persons.

Risks include:

- Injury to eyes.
- Hearing loss due to exposure to noise
- Injury to head, hand, foot or other body area
- Respiratory disease
- Increased exposure to mercury
- Electric shock
- Fire and burns

Image 10 : Risk of injury.

ACTIVITY

As a group, discuss the following questions:

1. What are the risks associated with different activities at your mine site?

2. Have you ever been exposed to these risks?

3. What are your top safety and security concerns?

4. What are the key factors that influence these risks?

Health Risks in Artisanal Mining

The health of artisanal miners is integral to their ability to conduct efficient operations. Health challenges in the artisanal gold sector are work-related, with exposure to public health related illnesses increasing at mine sites. Artisanal gold mining occurs in remote areas with minimum access to public health services. In addition, they often lack proper sanitation and hygiene facilities, as well as having minimal shelter for workers, increasing exposure to health risks.

Health problems common in the artisanal gold mining sector vary by context including climate and region, location, type of mining, as well as the local community's practices and beliefs.

WORK-RELATED ILLNESSES

- Respiratory disease such as Tuberculosis or Pneumoconiosis
- Musco-skeletal diseases
- Hearing loss
- Vision loss
- Mercury poisoning
- Nerve problems such as tremors
- Body pains
- Mental illness

PUBLIC HEALTH RELATED ILLNESSES

- Malaria
- Bilharzia
- Cholera, Typhoid
- Sexually transmitted diseases and HIV

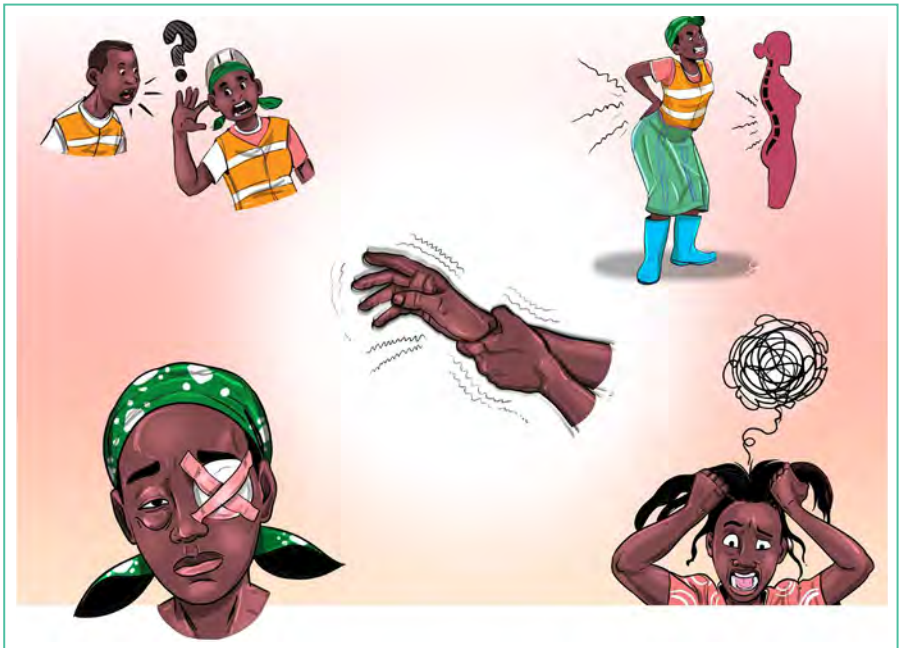

Image 11 : Work related illnesses.

Water and Sanitation

Across mine sites, miners may struggle with the availability of clean drinking water or water is contaminated due to mining activities.

Many artisanal mine sites are remote and lack the ability to establish clean water sources. Mine sites can get crowded, creating a burden on local water sources. While in other sites, availability of water is not an issue, the water becomes contaminated from mine site processing and poor waste management practices. This makes the local water unfit for human consumption, as well as can poison the livestock and agriculture that depend on that water source.

Lack of clean water and poor sanitation is linked to the spread of several diseases including cholera and typhoid.

MALARIA

Malaria is a disease caused by infected mosquitos. Mining pits with stagnant water are breeding grounds for mosquitos.

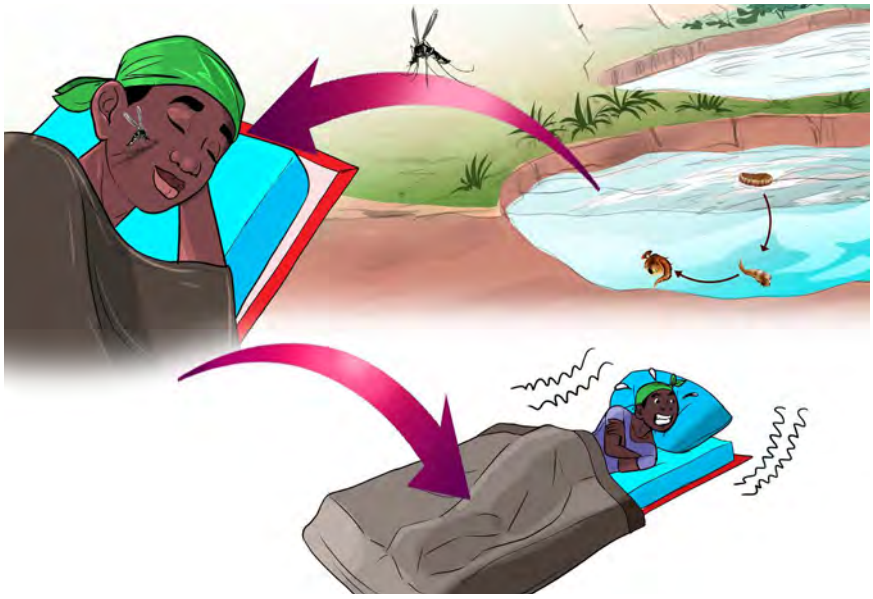

Image 12 : Malaria at mining sites.

CHOLERA AND TYPHOID

Poor sanitation and hygiene in crowded areas can contribute to waterborne illnesses such as cholera and typhoid.

Image 13 : Cholera or Typhoid at mining sites.

Risks associated with water and sanitation often found at mine sites:

- Use of local water sources for processing and tailings discharge
- Disposal of processing water to local water sources
- Use and disposal of chemicals such as mercury near local water sources
- Lack of adequate, safe drinking water
- Lack of toilets or designated location for pit latrines
- Lack of hand washing points
- Disposal of trash into local water sources
- Stagnant water breeds mosquitos

Access to Health Care

Artisanal gold mines are often far from local health services and payment for health services can be expensive, when available. Miners often delay seeking support for illnesses or injury due to the prohibitive cost, distance, and lack of transportation options.

In some countries, a police report is required for a miner to access health care in the event of an accident at a mine site. This deters miners to avoid reporting and seeking treatment for their injuries.

To address barriers in accessing health care:

- Map available community and public health services
- Organize miners' solidarity saving groups to contribute to payment of health care costs
- Ensure there is a first aid kit at the mine site
- Ensure miners are trained to administer first aid
- Ensure there is risk assessment and reporting at the mine site

Image 14 : How to address barriers to health care.

ACTIVITY

As a group, discuss the following questions:

1. What are some of the health challenges at your mine site?

2. Does your mine site have clean drinking water?
   Do all miners protect the local water sources?

3. What are some ways to make the entire mine site aware of the importance of protecting the local water sources?

4. Are health care services readily available to you and others at the mine site?

5. What are some of the barriers to accessing health care?

As a group or divided into two groups, map the available community health care services. Include any of the following: health care testing and treatment, community health workers and outreach, testing and treatment for infections including sexually transmitted infections (STI), distribution of condoms, distribution of mosquito nets.

As a group or divided into two groups, discuss how access to health care can be improved. Ideas can include creating a local savings group, advocating for the mine site to be included in existing programs, or mobile services that reach the mine site.

Other Health and Safety Risks

Artisanal mining activities generally take place close to, and sometimes even within, communities. In addition to contamination of water sources and sanitation, community members can face additional risks by the proximity of a mine site.

Presence of Children

Child labour is prohibited and detrimental to children's well-being. Sometimes, children live near mine sites or mothers must bring their young children to the site due to a lack of available day care options. Children should be kept away from mining pits, tunnels, processing areas, and equipment due to the risk of injury, sexual abuse, the worst forms of child labour, and death.

To decrease the risk for children:

- Establish safe play areas away from working areas
- Always supervise children
- Teach children basic safety rules

Image 15-A : Decrease risk for children at mine sites.

Image 15-B : Teach children basic safety rules.

Sexually Transmitted Infections (STIs)

A sexually transmitted infection is an infection that is spread by unprotected sexual activity. The risk for sexually transmitted infections increases when miners and nearby community members engage in unprotected sexual activity with multiple partners.

One of the most effective methods of protection against sexually transmitted infection is condoms.

Image 16 : Condoms are one of the most effective ways to protect against sexually transmitted infections.

Alcohol and Substance Abuse

Miners and members from the nearby communities can suffer from alcohol and substance abuse. This can lead to increased accidents at the mine site, loss of income, engaging in high-risk behaviour, poor personal relationships and conflicts with other workers, mental health issues, and loss of work.

At the mine site, use of alcohol and other substances must be prohibited. Equipment should not be operated under the influence of drugs or alcohol. Anyone suspected to be under the influence of drugs or alcohol should be reported to the mine site leaders. Information sessions should be organized at the mine site and surrounding communities about the dangers of consuming drugs and alcohol. Collaboration with local organizations focused on public health and counselling support should be explored to provide individuals with services when needed.

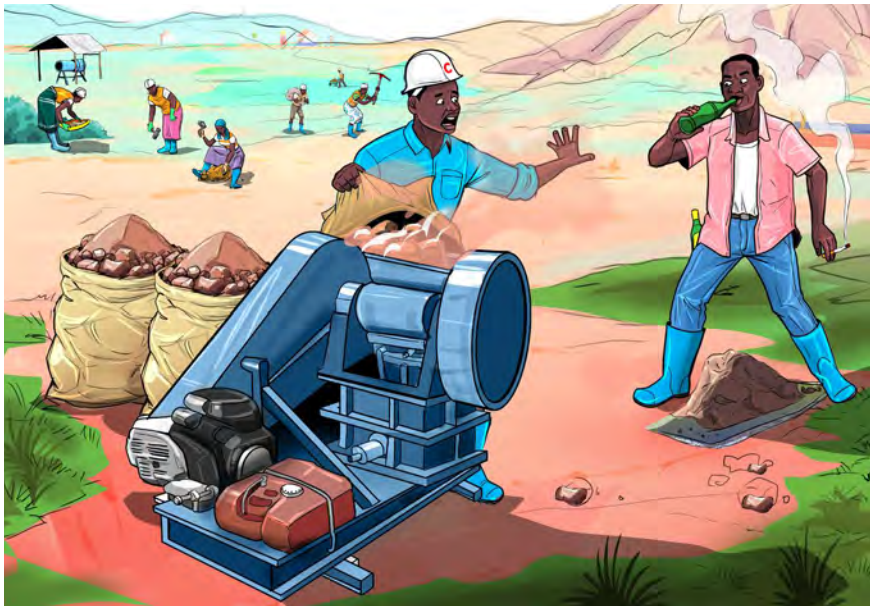

Image 17 : At the mine site, consumption of alcohol and other intoxicating substances must be prohibited.

ACTIVITY

As a group, discuss the following questions:

1. What are some of the health and safety risks the nearby community faces?

2. How can we decrease these risks?

3. How can the community support improving the health and safety at the mine site?

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MODULE 4:
HOW TO IMPROVE HEALTH AND SAFETY AT MINE SITES

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Learning Outcomes

BY THE END OF THIS SESSION, PARTICIPANTS SHOULD DEMONSTRATE:

- Increased understanding of methods to improve health and safety at artisanal and small-scale mining (ASM) sites
- Awareness on best practices to improve health and safety on ASM sites, including:
  - Different roles and responsibilities for worker health and safety, including their own
  - How to organize a mine site to ensure health and safety is respected
  - Different levels of hazards
  - Key elements in mine site reporting
  - When and how to wear Personal Protective Equipment
  - Best practices to prevent injury and disease

NOTE TO THE FACILITATOR

This training can be completed in a classroom or meeting room setting. Activities are focused on discussion questions. Hands-on learning is suggested when possible and appropriate.

Implementing Health and Safety Improvements

Artisanal and small-scale miners (ASM) can create safe working conditions by implementing best practices around health and safety at mine sites. The overarching requirement is to create a culture of good health and safety at work at the site.

To do this, the mine site leadership and miners need to:

- Comply with mining regulations and guidelines
- Establish and enforce best practices on health and safety at work
- Collaborate with other organizations within their area who can support their health and safety efforts

Health and Safety Regulations

Artisanal mining groups and miners should try to comply with their country's regulations on health and safety. Where regulations exist, they aim to provide workers with healthy and safe working conditions.

Some regulations may feel demanding. However, they identify best practices such as addressing workplace hazards, risk assessments, and improving health and safety within the mine site that can support compliance with the law. Complying with these regulations will lead to a safer workplace. Some of these best practices are detailed within this module.

NOTE TO THE FACILITATOR

Ahead of the training, the trainer should research and become informed about the health and safety laws applicable to ASM in the community. This section can be adapted to introduce key points from the local regulations.

Responsibilities of Workplace Health and Safety

Occupational health and safety are important for each worker, as they need to ensure they are safe from workplace accidents and disease by following best practices.

It is the responsibility of a miner to ensure that they are safe from workplace accidents and diseases. The government is responsible for providing and enforcing workplace policies applicable to the ASM sector. The mining groups and mining leadership support and give guidance on implementation and compliance with the ASM workplace policies, for example providing Personal Protective Equipment (PPE) and ensuring it is worn.

SAFETY FIRST

The priority for everyone at the mine site should be safety. Safety can improve production and profit. On the other hand, a lack of safety can cause accidents, deaths, loss of time, lower production, lower profits, and even lead to site closure.

All workers need to remember the slogan, Safety First. Safety is important during mining work and if conditions are not safe, work should stop. This is not only in mining, but even at home and other work we do.

DAILY SAFETY RULES FOR MINERS

- **Stay alert:** Always be aware of your surroundings
- **Use tools properly:** Follow instructions for safe use
- **Wear PPE:** Always wear personal protective equipment

Image 1 : Daily safety rules for miners.

ACTIVITY

As a group, discuss the following questions:

1. Discuss the challenges to follow health and safety regulations or guidelines within your mine site. Adapt the questions depending on the context to discuss legal regulations or guidelines set by the mine site itself.

2. What benefits do you see in following health and safety regulations or guidelines?

3. What can be done for miners to comply with the regulations or guidelines?

4. When we do a task at home (example: Light a fire, pull water from an open well), what do we do to ensure there is maximum safety? Do you practice **"Safety First"** at home?

5. How do you understand safety in mining? Do you practice **"Safety First"** at the mine site? Why or why not?

Organizing a Mine Site for Health and Safety

Mine Site Planning

A mine site is a working space for miners and should provide a safe working environment. Safety can be achieved through appropriate mine site organization and planning. Organization and planning at a mine site can ensure an environment that will eliminate or minimize safety and health risks.

This could involve but is not limited to:

- Policy development and implementation at the mine site
- Safety protocols
- Safety talks
- Site planning and appropriate allocation of workspaces (*further discussed below*)

POLICIES

- Mine site policies should state:
  - Safety and health responsibilities
  - Compliance requirements
- Policies should include responsibilities of different actors to support health and safety, requirements for mine support, protective clothing, prohibition of child labour, access controls, gender equality, guidelines for sanitation, and guidance on potable water use.
- The policies should be simple and implementable at the scale of the operation.

SAFETY PROTOCOLS

- Safety protocols are important and should become slogans for the mine operations. Examples include "Safety First" or "No PPE no Work". These protocols help move miners towards a desired practice.
- A mine site should have a first aid kit which is kept in an accessible area. Some miners should be trained to administer first aid to others.
- An incident or accident reporting protocol should be in place instructing how an accident is reported and recorded to the mine leaders.
- The five point safety plan can be adopted as a protocol to develop a safety culture within the mine organisation:
  1. Check the safety of the entrance or the point used to access the workplace. This could be the entry to a shaft or tunnel, or area to enter a pit or processing plant area.
  2. Check that the workers are healthy or uninjured and equipment is in good working order.
  3. Check that the work is being done safely to verify that workers are complying with good safety behaviour.
  4. Carry out corrective measures if you deem something unsafe.
  5. Ensure that workers and equipment continue to work safely.

Image 2 : No PPE, no work.

Image 3 : A mine site should have a first aid kit which is kept in an accessible area.

Image 4 : An accident reporting protocol should be in place instructing how an accident is reported and recorded to the mine leaders.

Image 5 : Check the safety of the entrance or the point used to access the workplace.

SAFETY TALKS

- Safety talks are important to discuss key topics with all workers, led by mine site leaders and other experienced or trained miners.
- These talks should be held frequently, at regular intervals, ideally daily, and at a suitable time to ensure everyone's participation.
- Feedback should be obtained from the miners on what is working and what needs to be improved for safety at the mine site.
- These talks should focus on safety priorities.

Topics may include:

- Proper use of PPE
- Surface and underground safety
- Safe use of equipment
- Safe work in areas with dust and noise
- Safer handling mercury
- Improved sanitation and hygiene

Image 6 : Safety talks are important to discuss key topics with all workers.

Mine Site Layout

When organizing the layout of a mine site, ensure you plan for optimal worker health and safety, as well as to ensure the safety of nearby families and communities.

Image 7 : Organize a mine site into different work zones with separate areas for different tasks such as extraction, processing, or burning amalgam.

DEFINED WORK ZONES

- The site should have a map where different stations are located including work sites, camp site, waste disposal, toilets, hand washing stations, processing areas, safe drinking water, and offices.
- Organize a mine site into different work zones with separate areas for different tasks such as extraction, processing, or burning amalgam.

LIMIT IMPACT ON COMMUNITY

As a rule, residential areas, offices and resting areas should not be downwind to avoid dust being blown towards the residents. Mine openings, mine waste, and the process tailings area should limit discharge of waste to the ecosystem.

PLAN FOR HEALTH AND SAFETY

- Plan for shelters which can provide protection from the weather to workers.
- It is a good practice for a mine site to have a waste disposal area for trash, first aid kit, and fire extinguishers.
- To address poor lighting in mining areas miners should use lighting in all work areas. In underground mining, light can be improved using headlamps and hand-held torches. Solar rechargeable lights can be used to improve lighting on a processing and milling site.

AVOID ACCIDENTS

- Keep paths and walkways well defined and clear of obstacles.
- Dangerous working areas should be clearly marked and protected to prevent accidents for people or animals:
  - Use barriers to mark dangerous zones.
  - Use clear signage to warn of hazards.

ACTIVITY

As a group, discuss the following questions:

1. What are the key things needed to organize a mine site to ensure health and safety?

2. In your mine site, what is currently being done to ensure health and safety?

3. What measures can be taken (by you and others) to better organize your mine site?

Prevention of Accidents

Artisanal miners are often at risk of accidents that could lead to injury or death, or cause loss of income, tools, and equipment. Sometimes underlying causes can contribute to accidents.

It is important to address these underlying causes to ensure they don't increase health and safety risks.

Conditions that lead to accidents:[1]

- Careless actions and work
- Use of faulty equipment
- Poor workplace organization
- Lack of training or adequate knowledge
- Poor mine and shaft support
- Insufficient ventilation
- Poor lighting
- Sleeping in working areas

Accidents may also be caused by immediate risks and human behaviour.
Some of the immediate causes of accidents are: [2]

- Undertaking a task without proper knowledge or guidance
- Non-compliance with workplace health and safety rules
- Lack of PPE use
- Using malfunctioning equipment or its improper use

To prevent future accidents from occurring, make sure to:

- Identify the cause of the accident any time one occurs
- Make every effort to address the conditions that caused the accident, especially minor accidents
- Eliminate causes of minor accidents which prevent larger accidents

Ongoing training will improve health and safety across ASM sites by:

- Updating skills: Learning new information
- Reducing risk: Acquiring new knowledge on appropriate health and safety practices
- Strengthening safety culture: Reminding people of the importance of safety

[1] Adapted from Government of Mongolia & SDC, 2015.
[2] Adapted from Government of Mongolia & SDC, 2015.

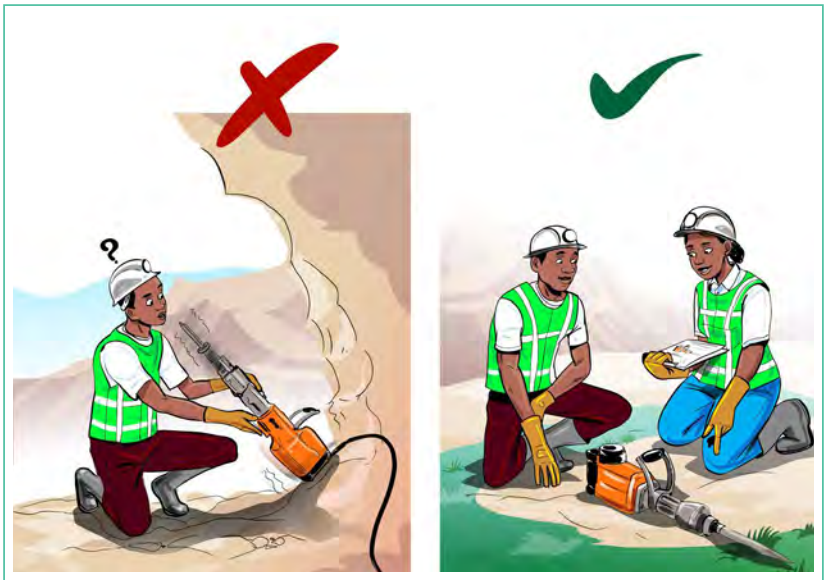

Image 8 : Accidents can be caused by undertaking a task without proper knowledge or guidance.

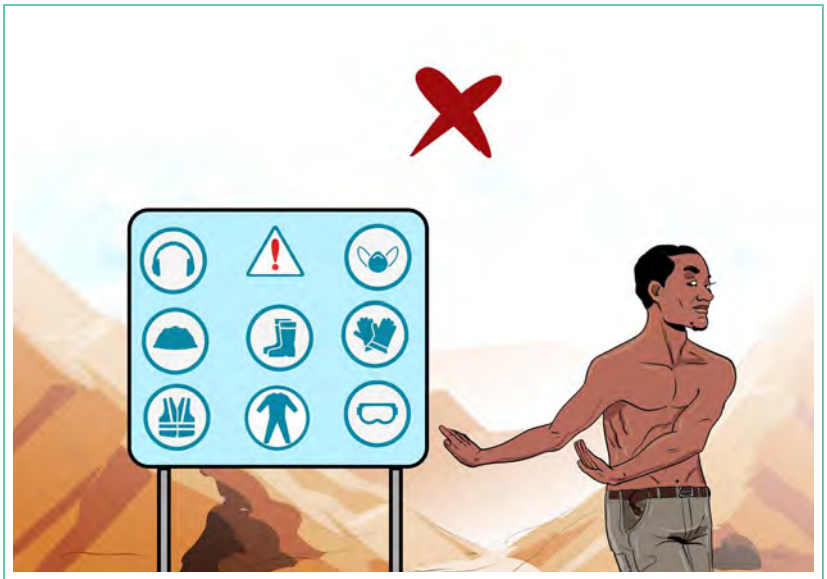

Image 9 : Accidents can be caused by non-compliance with workplace health and safety rules.

Risk Assessment and Reporting

A Risk Assessment is the practice of checking the workplace for hazards and dangers and then making the effort to manage or prevent potential harm from the hazard. An example is taking note of a dangerous mine entrance and mitigating the hazard by improving the mine entrance structure. Miners should make it a habit to identify risks and lower the possibility of having accidents.

DIFFERENT CATEGORIES OF HAZARDS AND RISKS

Hazards with low risk:

- A minor injury which does not affect the worker's ability to work
- A minor equipment malfunction that does not result in suspension of operations

Hazards with medium risk:

- Accidents that can cause temporary disability of the worker
- Short-term closure of the operation

Hazards with high-level risk:
- Loss of lives
- Permanent disability
- High level of damage to property and equipment

Identifying and Reporting Hazards

It is good practice to report risks and hazards identified during work or during an inspection. In some sites, complaints books or boxes are used to lodge complaints or reports on unsafe practices or hazards. It should be encouraged for miners to report to their supervisor or the next person with authority on risks they identify during their work. If these are not reported, corrective measures may be delayed or not taken, leading to accidents or even death.

Make it a routine to identify and report hazards:
- Look for dangers
- Check for unsafe conditions
- Report immediately: tell a supervisor, manager, or site owner
- Fix the problem: if possible, make the area safe right away or stop work and instruct workers to leave the area immediately

Image 10 : Make it a routine to identify and report hazards.

Accidents should be reported too. Miners often avoid reporting accidents out of fear. Reporting informs the site management or mining group of the type of accidents prevalent at the site to plan corrective measures. An immediate report can also lead to medical attention for the people involved in the accident. The mine site should keep a record of previous accidents to inform planning and improvements.

Mine Site Inspections

Those working within a mine site including a mining group, mine site owners, leaders, or the miners themselves can establish a culture of conducting mine site inspections or audits of the mining area regularly.

This can involve:
- Checking and addressing mining related hazards
- Checking how workers comply with good safety and health practices
- Workers registration at mine site and use of miner identity cards
- Correct use of safety equipment
- Application of appropriate mining practices including correct use of equipment
- Use of designated amalgamation locations and retorts in gold recovery
- Appropriate sanitation including use of toilets and clean drinking water
- Correct disposal of site waste

ACTIVITY

As a group, discuss the following questions:

1. What are the hazards that are most common at your mine site Categorize them as high risk, medium risk, and low risk.

2. For any hazards identified as "high risk" what are the steps that can be taken to prevent accidents?

3. What are the main strategies miners currently employ to avoid accidents?

4. What steps can miners take to ensure there are less accidents?

Personal Protective Equipment

Personal Protective Equipment (PPE) is equipment worn to minimize exposure to various hazards including accidents, excessive noise, dust, chemical burns, and more. In the mining sector, PPE is used to protect miners from various hazards that the miner is exposed to during mining, processing, and gold recovery.

PPE is the last protection when everything else has failed.

This means that a miner needs to have their workplace safe, in addition to regularly using PPE. For example, if a mine shaft is not well supported and the mine collapses, it will still bury workers wearing PPE. PPE is not enough if the underlying hazardous conditions are not addressed.

NOTE TO THE FACILITATOR

If possible and appropriate, examples of the PPE can be brought in.
Their proper use can be demonstrated with participants.

Different Personal Protective Equipment

PPE	ROLE OF PPE
Safety Goggles	Goggles protect the eyes from dust, dirt, and flying objects such as stones and bits of wood.
Ear Protection	Working in environments in which there is excessive noise can be detrimental to health, leading to headaches and potential hearing loss, including deafness. It is therefore important to wear ear protection such as earplugs or earmuffs to prevent damage to the ears.
Protective Masks	Masks should be worn in dusty and dirty workplaces to prevent damage to respiratory organs and the development of occupational diseases.
Helmets	Helmets are used to protect the head from falling objects.
Gloves and Elbow Protectors	Gloves and elbow protectors are used to prevent bodily damage resulting from cuts, scratches, burns, and injury from metal and stones.
Safety Shoes/ Boots, Knee Protection	Feet and knee protectors protect the feet and legs from damage caused by slipping, falling, and the dropping of heavy and/or sharp objects.
Work Uniforms	A proper work uniform consisting of overalls and a jacket with reflective ribbons is important. Work clothes must be comfortable to wear, work in, and must be protective.

Image 11 : Different PPE.

Improper Use of Personal Protective Equipment

Artisanal miners generally do not use PPE consistently. There are many reasons for this, including:

- PPE is expensive and not affordable
- PPE is uncomfortable
- Lack of awareness about the need for PPE
- They believe it is not necessary

The availability of PPE is often a problem. Miners get their PPE from 1) their workplace, 2) they buy it themselves, or 3) from their co-workers. In most cases, PPE is not provided at the workplace. As a result, most miners work without PPE, exposing them to multiple hazards.

Often, even when miners have access to PPE, they do not use it or use it improperly. Miners often blame discomfort for not using PPE. While there are ongoing efforts to design more comfortable PPE, the primary purpose is safety over comfort.

Examples of bad practices with PPE use:

- Working underground without a hard hat and safety boots.
- Working in dusty areas without dust masks
- Working in noisy areas without ear protection
- Crushing rocks without eye protection
- Burning amalgam without retort and masks

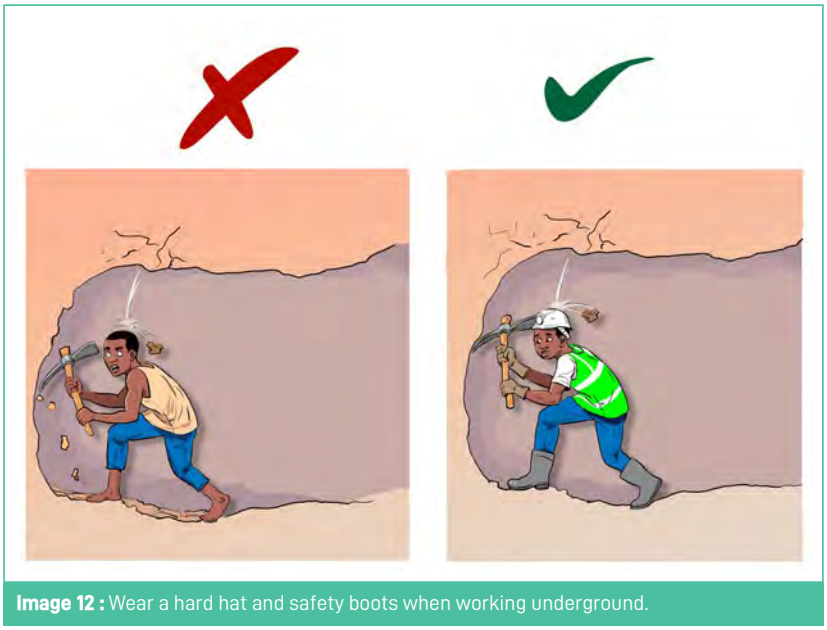

Image 12 : Wear a hard hat and safety boots when working underground.

Image 13 : Wear a dust mask and eye protection when crushing rocks or in dusty areas.

Image 14 : Wear a mask and use a retort when burning amalgam.

Image 15 : Wear ear protection when working in a noisy area.

Proper Use of Personal Protective Equipment

TIPS FOR THE PROPER USE OF PPE

- **Proper fit:** Ensure PPE fits well, and the size should match what the worker needs
- **Relevant:** Ensure you are wearing the proper PPE for the work you are doing
- **Storage:** Keep in a safe and dry place where it is accessible for daily use
- **Check regularly:** Inspect PPE for damage
- **Keep accessible:** Keep it close to you all the time when working, ready for use
- **Replace as needed:** Replace worn or damaged PPE as needed

PPE FOR WOMEN MINERS

Traditional PPE has been designed for men, however in recent years, designs better suited for women are being introduced to the market. These include appropriate shoe and coverall sizes, light material for work suits, and boots. Women in pregnancy also need appropriate PPE designed for them in line with their roles in the mining supply chain.

PPE TIPS FOR WOMEN

- **Proper fit:** Ensure PPE is available in sizes that fit women
- **Comfort:** Choose PPE that is comfortable for long use
- **Special needs:** Consider PPE for pregnant women
- **Culturally relevant:** The attire should reflect cultural values for both men and women.

ACTIVITY

As a group, discuss the following questions:

1. What type of PPE is the most common among miners in your mine site?

2. What are the reasons you or other miners at your site do not wear PPE?

3. What do you think is the most important PPE your mine site needs?

4. Who has access to PPE currently? Who provides PPE? Can this be better distributed?

5. What are the changes that can be made to encourage better PPE use?

Basic Health Tips for Miners

WASTE

- Dispose of trash in designated pits.

WATER

- Use safe drinking water separate from contaminated water from mine site operations.
- Most ASM areas get water from open rivers, lakes, ponds, and wells with unclean and unprotected water. Water for drinking or food preparation should be taken from protected safe sources like boreholes.
- Boil drinking water. This kills organisms to kill organisms linked to the spread of cholera and typhoid.
- Store drinking water in clean and covered containers. Water should be poured directly from the container, rather than using a handleless cup.

SANITATION

- Designate toilets or pit latrines, at least 30 metres away from water sources.
- Ensure separate toilets for women and men.
- Keep toilets clean
- Wash hands regularly with soap.
- Work together to keep the mine site clean.
- Backfill pits with bio-degradable waste and cover with topsoil.

SANITATION FOR WOMEN

- Designate relevant sanitary facilities for women.
- Ensure privacy in washing and toilet areas.
- Provide relevant sanitary provisions and disposal methods.

Additional health tips are available in *Module 3: Health and Safety Risks at Mine Sites.*

Image 16 : Dispose of trash in designated pits.

Image 17 : Water for drinking or food preparation should be taken from protected safe sources like boreholes.

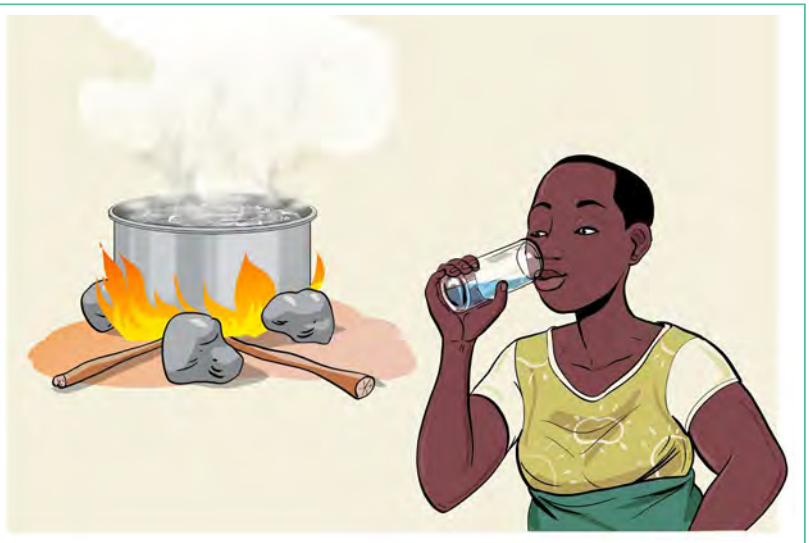

Image 18 : Boil drinking water.

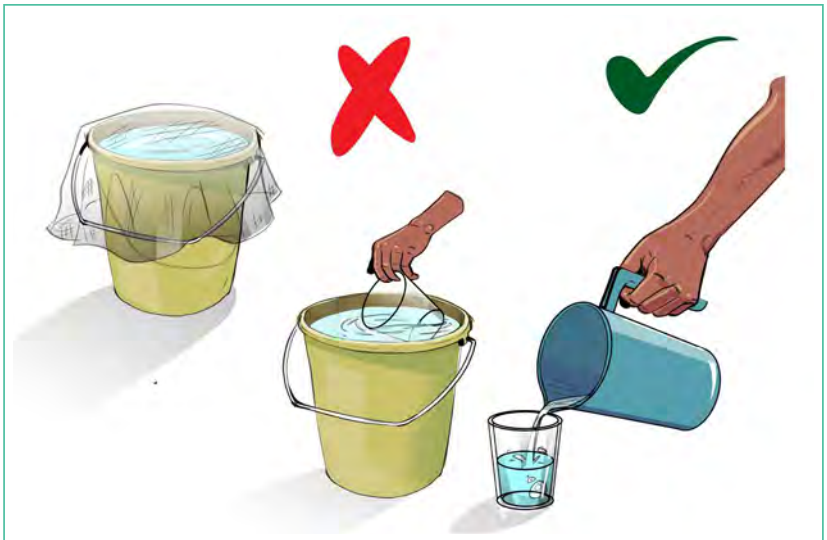

Image 19 : Water should be poured directly from the container, rather than using a handleless cup.

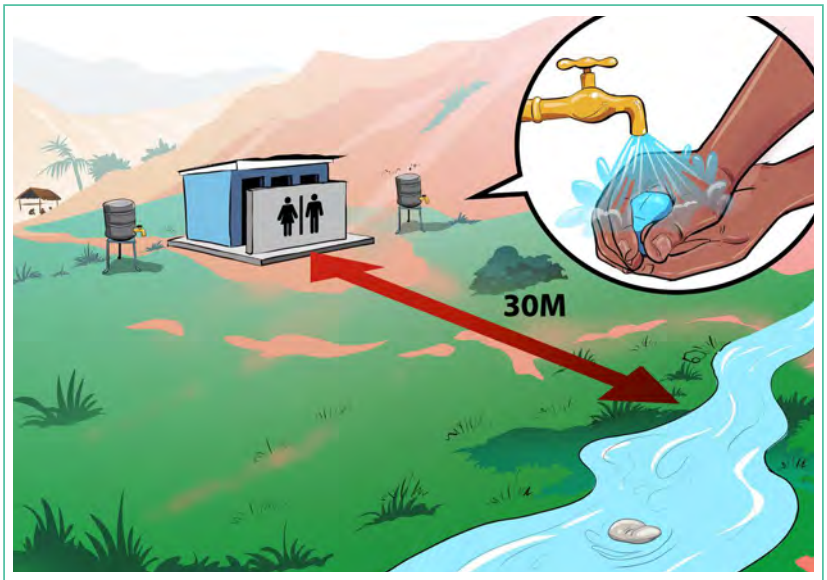

Image 20 : Designate toilets or pit latrines, at least 30 metres away from water sources.

ACTIVITY

As a group, discuss the following questions:

1. How can your mine site be better organized to improve health for miners? What about women's needs?

Reducing Injury from Equipment

- Always use PPE including gloves, eye protection, ear protection, hard hats, and boots.
- Always wait until a machine is turned off before fixing or maintaining equipment.
- Maintain equipment and tools regularly.
  Your investment in this will allow you to continue to work for a longer time.
- Put housings or casings around machinery to reduce dust and noise associated with equipment.
- Replace tools including hammers and pickaxes (especially the handles or heads) as they wear down.
  They will reduce productivity as they wear out.
- Put up signs around the locations requiring protection against equipment
  to make sure miners are always cautious.
- Keep children and people not working in the area out with signs and barriers.
- Store equipment and tools in a proper place.

ACTIVITY

As a group, discuss the following questions:

1. How can your mine site be better organized to improve health for miners?
   What about women's needs?

Safe Handling of Chemicals

Mercury, nitric acids, caustic soda and cyanide are common harmful chemicals in artisanal gold mining operations.

Mercury is used during the gold recovery process. Nitric acid is used in the cleaning of gold by buyers and at the smelter. It is also used in cyanidation plant operations when mixed with hydrochloric acid for testing gold dissolution. Caustic soda and cyanide are used by processing plants for treatment of gold containing tailings. Caustic soda regulates the alkalinity of the solution to optimise gold extraction from the tailings.

How Can Miners Handle Chemicals Safely?

- Establish good storage of chemicals by:
  - Clear labelling of chemical containers
  - Keep chemicals in safe and locked area
  - Different chemicals should be stored separately

- Establish good disposal protocols for chemicals by:
  - Following guidelines on chemical containers
  - Avoiding throwing away chemicals in water or soil
  - Use containers to throw away chemicals

- Use appropriate PPE when handling chemicals.
  - Use of gloves, appropriate masks and coveralls, and safety shoes or plastic boots when handling chemicals
  - Chemicals are both toxic and flammable. They cause burns when they react with bare skin

10 TIPS ON SAFER CHEMICAL HANDLING[3]

1. Train the staff working with chemicals.
2. Do not handle chemicals under the influence of drugs or alcohol.
3. Do not allow children or others to gather near the treatment area.
4. Always use chemicals in a designated area separate from others.
5. Always wear appropriate PPE including goggles, boots, gloves, and a mask designed to filter the fumes of chemicals.
6. Always ensure chemicals are stored in containers with caps and lids that close tightly.
7. If chemicals touch skin, wash immediately with warm soapy water and rinse thoroughly.
8. If chemicals get into the eyes, rinse immediately with cold water.
9. Dispose of chemicals securely, according to the mine site chemical management policy.
10. Use alternatives to chemicals when possible.

[3] https://impacttransform.org/wp-content/uploads/2022/11/IMPACT_Poster_Chemincals_Aug-2022_EN-WEB.pdf

Image 21 : Establish good storage of chemicals.

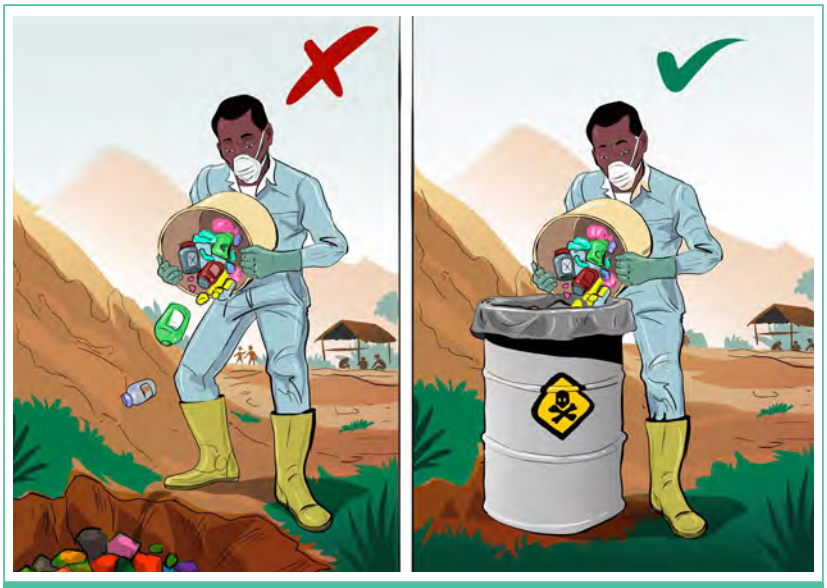

Image 22 : Establish good disposal protocols for chemicals.

ACTIVITY

As a group, discuss the following questions:

1. How does your mine site currently store and dispose of chemicals?

2. What steps can miners take to improve the how chemicals are stored and disposed of?

Roles and Responsibilities for Health and Safety

To ensure health and safety at the mine site, everyone needs to understand their role and responsibility towards this goal.

MINING GROUP LEADERS AND MINE SITE LEADERS

Overall ensure safe working conditions by providing policies, supporting implementation, and demanding compliance on issues such as:

- Safety of shaft supports and timbering
- Adequate mine ventilation
- Safety of equipment, tools, and other materials used
- Dangers on equipment including their moving parts
- Conditions that may cause slips and falls
- Dangers that may result in workers being struck by objects
- Dangers posed by any materials or objects that could burn
- Anything hazardous to human health
- If the power supply is safe
- If the emergency exists are clear
- If the fire extinguisher and other protective equipment are complete and ready to be used

MINING GROUP MEMBERS

Mining group members and miners should know and understand occupational health and safety rules. They must follow safety instructions. Safety and health talks must be given regularly. They should follow health and safety procedures on issues such as:

- Compliance with operational safety regulations and instructions
- Checking their safety and protective gear
- Checking equipment conditions
- Not engaging in or undertaking hazardous actions or substances (alcohol, drugs)
- Sharing or reporting information on workplaces with potential dangers
- Only performing tasks they are confident they are skilled in
- Regularly assessing potential workplace hazards
- Learning techniques required to perform tasks properly
- Attending operational safety and health training
- Taking immediate actions when hazards are identified
- Immediate reporting of risks and hazards

ACTIVITY

As a group, discuss the following questions:

1. What are the current roles occupied by the mine site group leaders versus miners to improve health and safety?

2. What could be done to ensure everyone owns their responsibility on health and safety?

NOTE TO THE FACILITATOR

As a final activity, if possible and appropriate, you can consider arranging a visit to the mine site to review some of the learnings from Module 4 or other relevant modules. Prepare a mine site inspection template or risk assessment ahead of time.

Participants can apply their learnings during a walkthrough of their mine site and together, fill out the template identifying the gaps and places where correction action needs to be taken to improve health and safety.

Using the information gathered from the mine site inspection or risk assessment, participants can prepare a safety plan for the mine site.

Both the results of the inspection and safety plan can be presented to the mine site leadership during a meeting around health and safety.

Resources Available

VIDEO:
PPE: Protection for Your Future
Learn what Personal Protective Equipment (PPE) you should be wearing at an artisanal mine site and why.

English : https://bit.ly/IMPACTPPE_VideoEN
French : https://bit.ly/IMPACTPPE_VideoFR
Baoule : https://bit.ly/IMPACTPPE_VideoBaoule
Dioula : https://bit.ly/IMPACTPPE_VideoDioula
Djimini : https://bit.ly/IMPACTPPE_VideoDjimini
Senoufo : https://bit.ly/IMPACTPPE_VideoSenoufo

VIDEO:
Improving Safety at the Mine Shaft
Learn how to construct a shaft at an artisanal mine site securely.

English : https://bit.ly/IMPACTMineShaftSafety_VideoEN
French : https://bit.ly/IMPACTMineShaftSafety_VideoFR
Baoule : https://bit.ly/IMPACTMineShaftSafety_VideoBaoule
Dioula : https://bit.ly/IMPACTMineShaftSafety_VideoDioula
Djimini : https://bit.ly/IMPACTMineShaftSafety_VideoDjimini
Senoufo : https://bit.ly/IMPACTMineShaftSafety_VideoSenoufo

POSTER:
Operating Mining and Processing Machines Safely
Steps to protect yourself and others at the mine site when operating machines for mining or processing.

English : https://bit.ly/IMPACTPosterOperatingMachines_EN
French : https://bit.ly/IMPACTPosterOperatingMachines_FR
Swahili : https://bit.ly/IMPACTPosterOperatingMachines_Swahili
Luganda : https://bit.ly/IMPACTPosterOperatingMachines_Luganda

POSTER:
Health & Safety: Responsibilities of Mine Site Operators
10 steps to ensure health and safety of miners.

English : https://bit.ly/IMPACTPosterResponsibilities_EN
French : https://bit.ly/IMPACTPosterResponsibilities_FR
Swahili : https://bit.ly/IMPACTPosterResponsibilities_Swahili
Luganda : https://bit.ly/IMPACTPosterResponsibilities_Luganda

POSTER:
Handling Chemicals Safely
10 steps to protect yourself and others when using chemicals such as mercury in mining and processing.

English : https://bit.ly/IMPACTPosterHandlingChemicals_EN
French : https://bit.ly/IMPACTPosterHandlingChemicals_FR
Swahili : https://bit.ly/IMPACTPosterHandlingChemicals_Swahili
Luganda : https://bit.ly/IMPACTPosterHandlingChemicals_Luganda

BROCHURE:
How to Rehabilitate a Mine Site
10 steps to take when closing a mine site to bring the land back to its natural state.

English: https://bit.ly/IMPACTMineSiteRehabilitation_EN
French: https://bit.ly/IMPACTMineSiteRehabilitation_FR

IMPACT transforms how natural resources are managed in areas where security and human rights are at risk. We investigate and develop approaches for natural resources to improve security, development, and equality. We are an independent non-profit, collaborating with local partners for lasting change.
www.impacttransform.org

The **planetGOLD Uganda** project aims to reduce the use of mercury by supporting formalization of the artisanal gold mining sector and increasing access to finance. This will lead to adoption of mercury-free technologies and allow access to more responsible and traceable gold supply chains. The project is supported by the Global Environment Facility, led by the UN Environment Programme, executed by IMPACT in partnership with Uganda's National Environment Management Authority and the country's Ministry of Energy and Mineral Development under the Department of Mines.
www.planetgold.org/uganda

The **planetGOLD Côte d'Ivoire** project aims to reduce the use of mercury in the artisanal gold mining sector through a holistic, multi-sectoral and integrated formalization approach. The project also aims to improve access to traceable gold supply chains and financing for the adoption of sustainable, effective and practical mercury-free technologies. The project is supported by the Global Environment Facility, led by the UN Environment Programme, executed by the Centre Africain pour la Santé Environnementale (CASE) and IMPACT.
www.planetgold.org/cote-divoire

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IMPACT
Transforming natural resource management
Empowering communities

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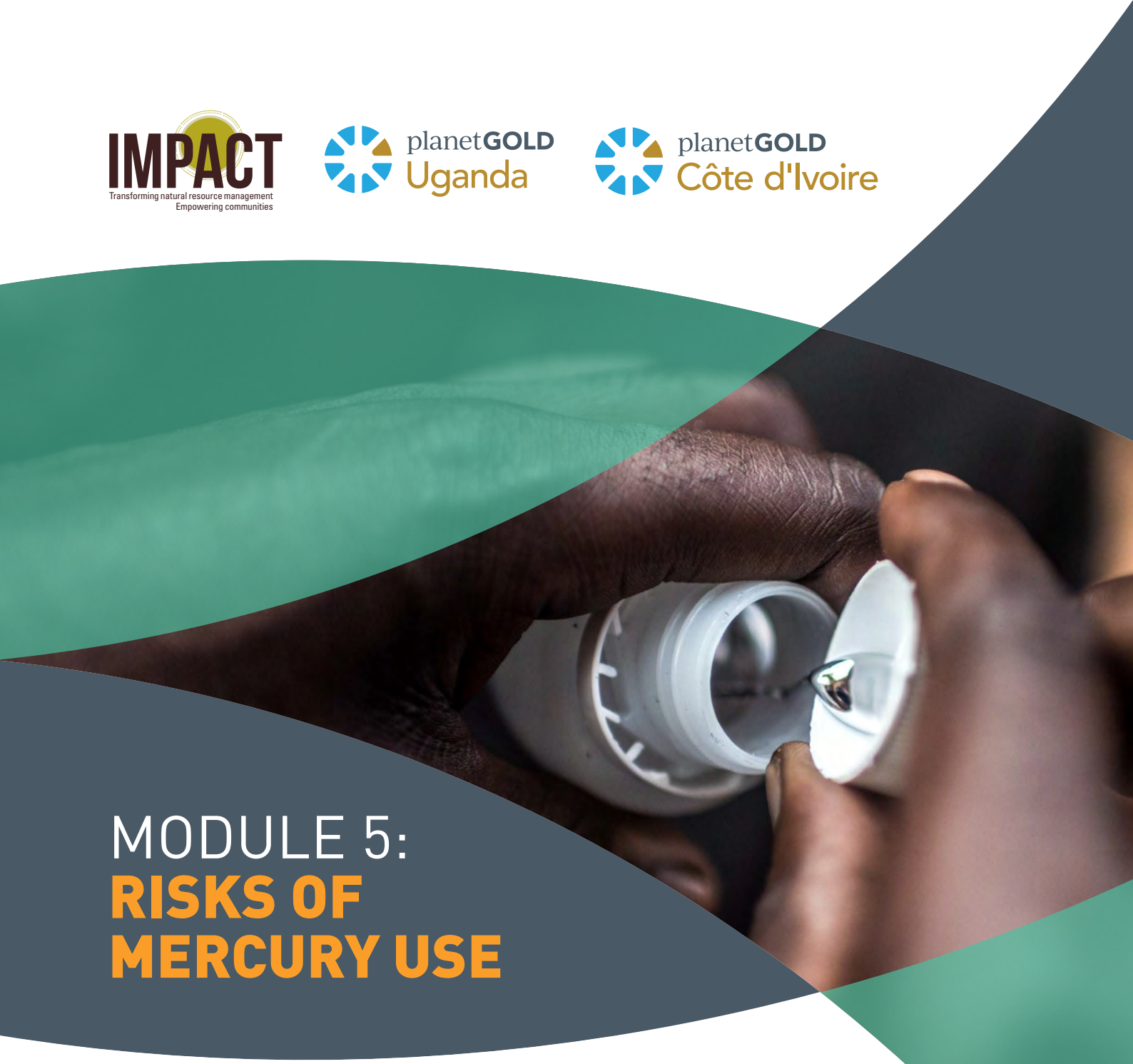

MODULE 5:
RISKS OF MERCURY USE

FACILITATOR'S GUIDE
Supporting Best Practices at Artisanal Gold Mines Toolkit

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In partnership with
Canada

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Modules 1, 4, 6, and **8** of the **Supporting Best Practices at Artisanal Gold Mines Toolkits** have been produced as part of the Supporting Women in ASM Communities in Mali project (FEMA) funded by Global Affairs Canada and implemented by Cowater.

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Learning Outcomes

BY THE END OF THIS SESSION, PARTICIPANTS SHOULD:

- Understand that mercury in artisanal gold mining is dangerous to humans and the environment
- Understand that mercury use is prohibited and miners are encouraged to improve their handling, reduce their use of the chemical and when possible, eliminate it
- Identify the different symptoms of mercury poisoning
- Understand the dangers of mercury for pregnant women and children
- Identify how mercury poisoning and contamination occurs in artisanal gold mining

NOTE TO THE FACILITATOR

This module aims to raise awareness about the dangers of mercury in artisanal gold mining. *Module 6: Safer Handling of Mercury* and *Module 7: Basic Techniques to Eliminate Mercury* provides information on how to address some of the risks associated with mercury use.

This training can be completed in a classroom or meeting room setting. Activities are focused on discussion questions. Hands-on learning is suggested when possible and appropriate.

Mercury in Artisanal Gold Mining

Mercury is widely used in artisanal and small-scale gold mining. However, mercury is a poisonous chemical. Using mercury in mining can result in health problems for miners, as well as the surrounding communities. It can contaminate the environment of the mine site and surroundings, as well as contribute to pollution of your country and the entire world.

Image 1 : Mercury contaminates the mine site and the community.

At each step when mercury is handled or used, it leads to the release of poisonous vapours, contamination of the soil and water, as well as chemical skin contact. It is the world's largest source of anthropogenic emissions due to human activity of mercury pollution.

Mercury Use

Mercury is used in different processes of artisanal gold mining.

- **Amalgamation:** Mercury is added to the concentrate containing gold. Amalgamation should only be for concentrates and not the whole ore. This means mercury should not be added on the sluice mats, or mill, or inside any concentrator. It should be added during the last stage of gold recovery after concentration or sluicing.
- **Mixing:** To help the mercury catch gold, mixing of mercury and the concentrate is often done. Miners often stand in contaminated water and mix with their bare hands.
- **Squeezing:** The amalgam is wrapped in a piece of cloth and squeezed to remove excess mercury from the gold amalgam. Miners often do this with their bare hands. The squeezing should be done while the wrapped amalgam ball
- **Burning:** To remove the mercury, the amalgam is burned over a fire. A retort should always be used to capture the vapour.
- **Handling:** Miners often handle the liquid mercury with bare hands and improperly storage the chemical.

Image 2 : Mercury is used in different processes of gold mining.

When mercury gets into contact with gold, it forms "amalgam." This is a mixture of mercury and gold. To separate gold from the amalgam, the amalgam is heated. Sometimes miners burn the amalgam or buyers provide this service. Gold can also be sold to traders and smelters as a gold sponge in which mercury has been removed using a retort. The sponge still contains other impurities and some mercury, which is removed during smelting.

Mercury is a silver metal which easily evaporates and is liquid at room temperature. Mercury is suitable for use with both small and large batches of ore, giving a high gold recovery if properly used to amalgamate concentrate. Mercury is frequently used in artisanal gold mining because it is simple to use, efficient, and easily available.

WHY IT'S POPULAR

- Easily available to miners
- Technique shared across generations and miners globally
- It is simple and easy to use
- Can work for very small quantities of gold
- It can be squeezed and re-used for another day
- Allows for quicker process and therefore profits for miners
- Allows for privacy as the miner does not have to use it in the presence of other miners

Using mercury is also cheaper than most equipment for mercury free gold recovery, however as the ban on mercury expands, the price of the chemical also increases, and it becomes harder to find.

Miners need to take steps to reduce and when possible, eliminate the use of mercury in their mining operations. In the meantime, due to its dangers, protecting oneself and others when using mercury is important.

Prohibition on Mercury

Due to the dangers of mercury to human health and the environment, countries around the world have signed an international commitment to reduce and eliminate the use of mercury, called the Minamata Convention. It is named after a place in Japan, where a whole community was poisoned and children were born with deformities as result of eating fish poisoned with mercury. There are numerous examples of people who have been poisoned with mercury in different countries. Studies have been done in Tanzania, Brazil, Zimbabwe, Laos, Mongolia, Indonesia, Guyana and these show that mercury poisoning has various adverse effects, including neurological diseases on miners, deformities in children, and more.

NOTE TO THE FACILITATOR

Ahead of the training, the trainer should research whether the country has ratified the Minamata Convention and any local regulations applicable to mercury. This section can be adapted to introduce key points from the local regulations and government efforts to reduce mercury use.

Countries that have ratified the Minamata Convention develop a National Action Plan to reduce and eliminate mercury use in gold mining. They set commitments to reduce and eliminate mercury use in the artisanal gold mining sector. Numerous countries have already brought in legislation banning the use of mercury in artisanal gold mining, making its use and trade illegal.

Image 3 : Countries have banned the use of mercury in artisanal gold mining.

Increasingly, buyers are becoming concerned about the risks associated with mercury and looking to buy "green gold." Over time, as international companies seek to report on environmental and development commitments, it may become more difficult to sell gold processed with mercury. Getting access to mercury will be very hard and expensive and most likely illegal. It is therefore important to start reducing the use of mercury and where possible start exploring alternatives.

ACTIVITY

As a group, discuss the following questions:

1. Is mercury commonly used by you or others in gold processing?

2. Is mercury easily accessible? Why?

3. What do you know about the impact mercury can have on your health or the environment?

4. If mercury is prohibited, will that make you stop using it? Why or why not?

Dangers of Mercury

Mercury is very dangerous to human health and the environment. While mercury can cause health impacts for anyone, it is extremely dangerous to young children and pregnant women and care must be taken to not expose them to any mercury.

Some symptoms of mercury poisoning may occur right away, while many health effects can take years or even decades after exposure. The impacts of mercury poisoning on an individual depend on the severity of the exposure (for example if it's direct or indirect), the individual, their gender, and their age. It is not often easy to tell if a person has mercury poisoning, as the symptoms can be confused with malaria or hunger.

If an individual has been working with or around mercury, it is important to undertake regular health check-ups to rule out mercury poisoning and receive medical assistance if required. In many cases, the effects of long- term mercury poisoning may be irreversible.

SYMPTOMS AND EFFECTS OF MERCURY POISONING

- Headaches
- Vomiting
- Trembling and shaking
- Weakness
- Loss of libido in men
- Infertility
- Brain damage or deformation to fetus
- Development delays in young children
- Numbness or dull pain in areas of the body
- Lack of muscle coordination
- Coughing, trouble breathing, chest problems
- Problems with eyesight
- Nerve damage
- Kidney problems
- Stomach problems
- Swollen or discolored gums
- Memory loss
- Insomnia
- Weak immune system leading to frequent illness

Mercury is especially dangerous for pregnant women and their unborn children, as well as young children. Mercury can cause problems with growth and development among fetuses and young children, learning challenges and disabilities. It can also cause damage or deformities to the fetus.

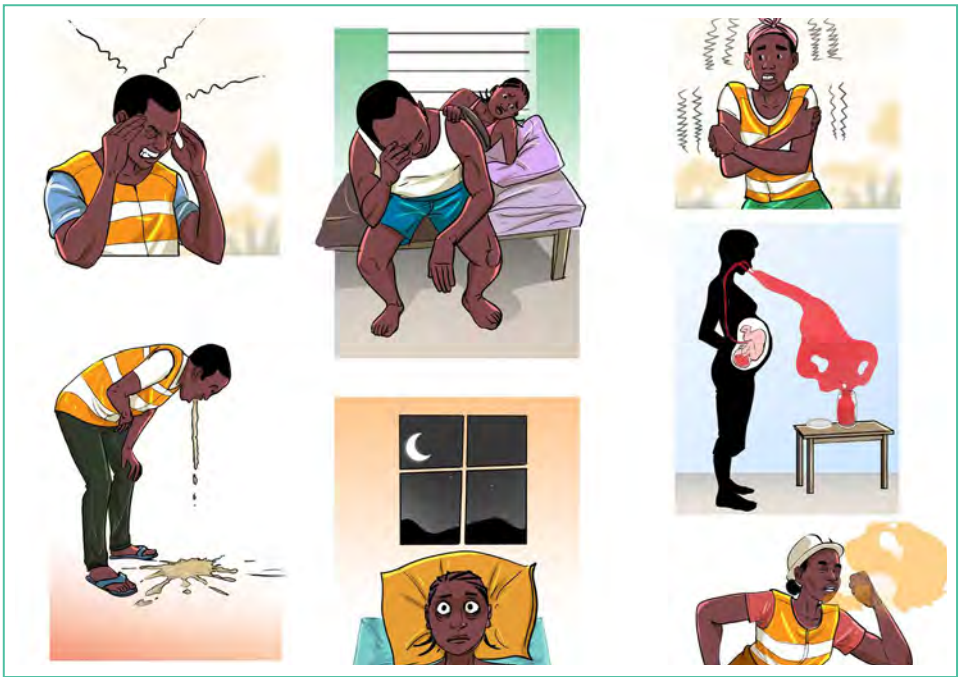

Image 4 : Symptoms and effects of mercury poisoning.

ACTIVITY

As a group, discuss the following questions:

1. What are the common beliefs or perceptions about the risks associated with mercury use at your mine site or community?
2. What are the symptoms of mercury poisoning?
3. Do you know anyone who has these symptoms? Do you think it could be due to mercury?
4. If you could tell other miners about the dangers of mercury, what would you tell them?
5. What ways can you seek medical help associated with mercury exposure or poisoning in your local area?

When Mercury Exposure Occurs

MERCURY EXPOSURE OCCURS BY

- Inhaling its vapours
  - When handling liquid mercury at regular temperatures
  - From a container not being closed properly
  - When burning it
- Touching it with bare hands
- Eating contaminated food
- Drinking contaminated water
- Working with tailings that have been exposed to mercury

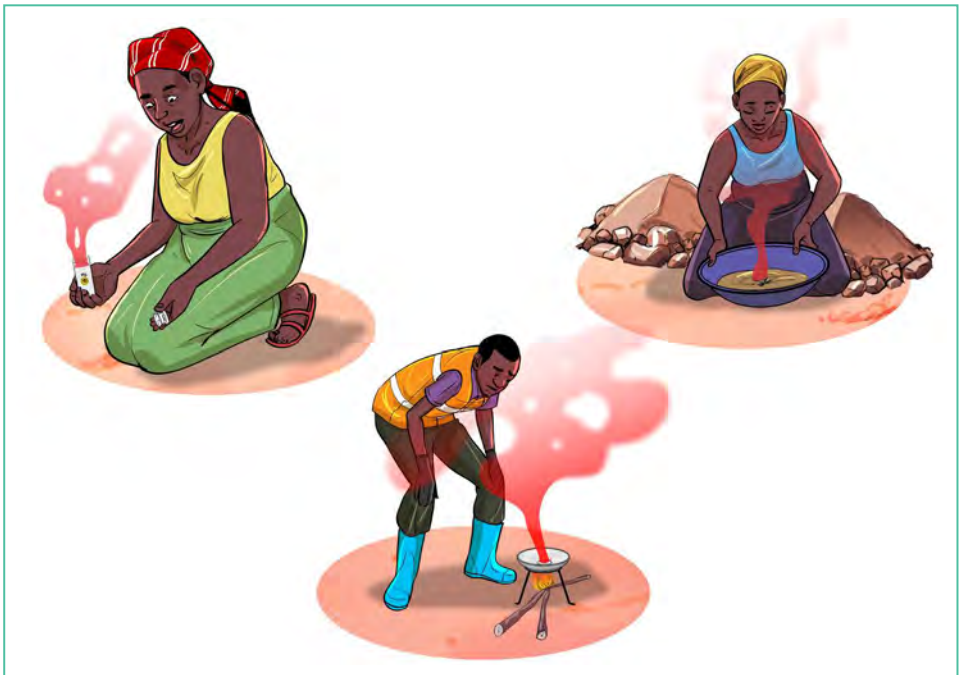

Image 5 : Mercury exposure occurs by inhaling its vapours.

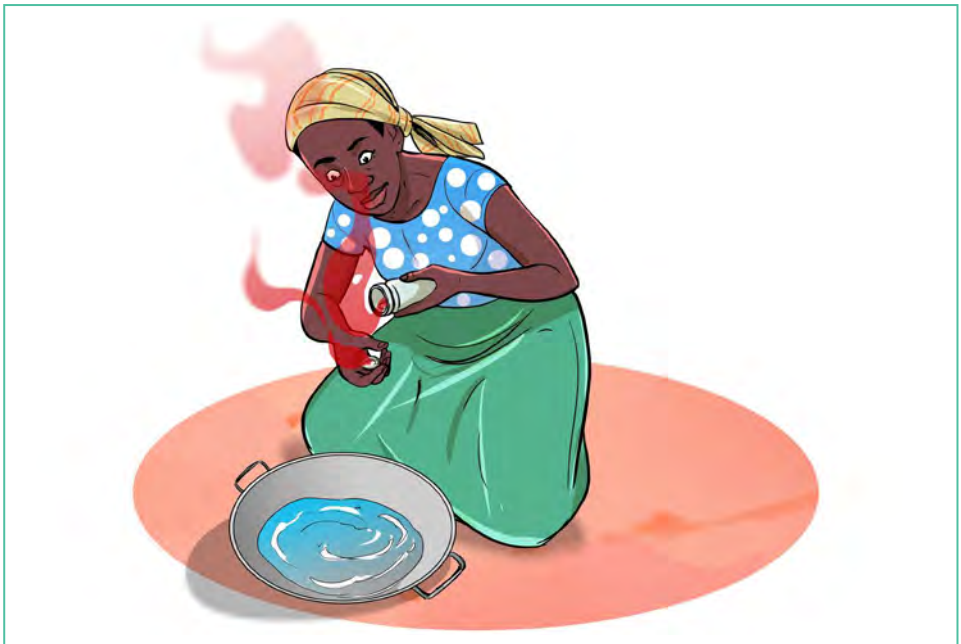

Image 6 : Mercury exposure occurs by touching it with bare hands.

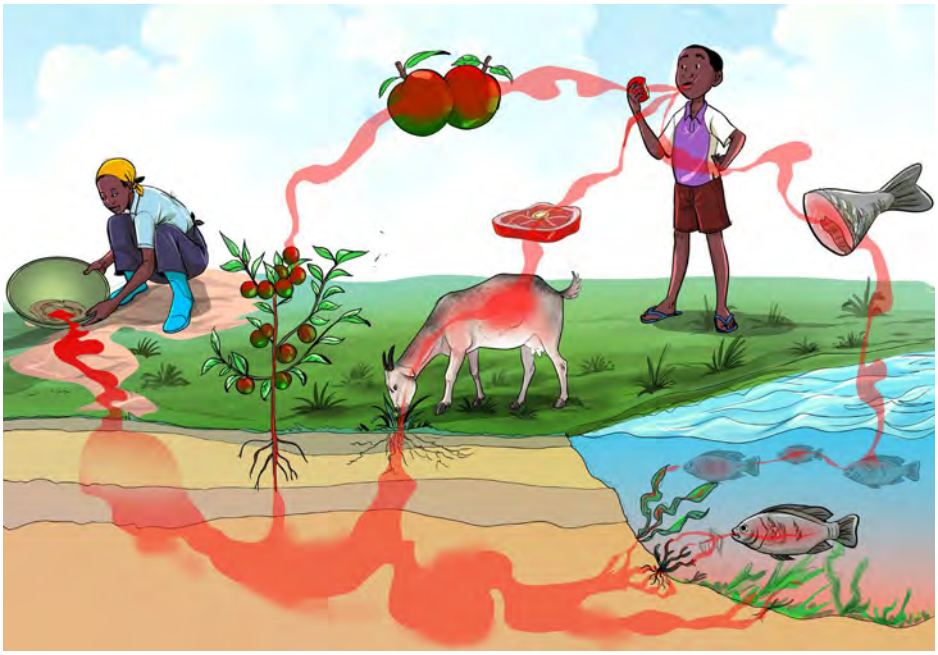

Image 7 : Mercury exposure occurs by eating contaminated food.

Image 8 : Mercury exposure occurs by drinking contaminated water.

Image 9 : Mercury exposure occurs by working with contaminated tailings.

Mercury vapour is very dangerous, but a miner can't see or smell it. This vapour remains in the air and is deposited on nearby objects and materials, including clothes or buildings, continuing to contaminate the environment long after the initial exposure.

The vapour can travel far with the wind before being deposited. This means that not only are miners directly at risk, but indirect exposure to the health risks of inhaling mercury vapours is a serious issue for their communities.

Additionally, leaching mercury contaminated tailings with cyanide transforms mercury to its more dangerous form: methylmercury which further contaminates the environment.

MERCURY CONTAMINATES THE ENVIRONMENT BY

- Seeping into the soil and groundwater
- Affecting local drinking water sources
- Entering the local food chain
- Affecting agriculture and plants that depend on the water and soil, such as bananas, potatoes, and other foods grown in local communities
- Poisoning livestock that drink from the water
- Poisoning fish that live in the water

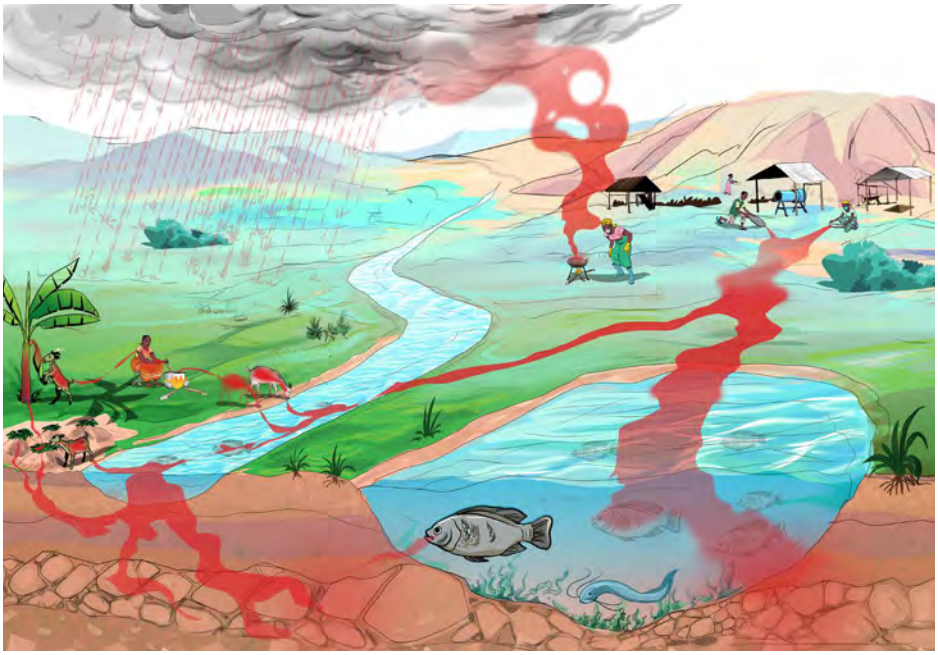

Image 10 : Mercury contaminates the environment.

How Mercury Poisoning and Contamination Occurs

Mercury will poison people and contaminate the environment during handling and storage across different activities of the mining supply chain.

STORAGE

- Mercury gives off vapours even at normal temperatures which one cannot see or smell
- If mercury is not stored properly these vapours are released into the air and environment
- Fumes can be released if: the container is not closed properly or the container is not airtight
- Containers containing mercury should not be stored in a residential area

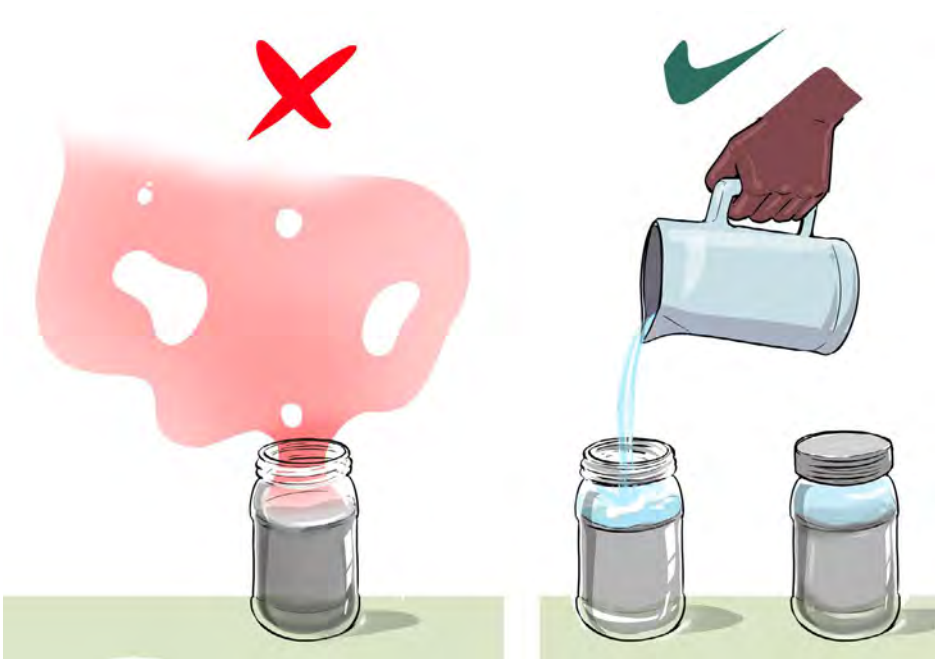

Image 11 : Fumes will be released if not stored properly.

DURING AMALGAMATION

- When being used at normal temperatures, the mercury is giving off poisonous vapours
- It is also poisoning the person if they touch liquid mercury directly with bare skin
- Miners may be poisoned by handling the liquid mercury and mixing the ore with mercury with their bare hands
- Miners may be poisoned if they stand in contaminated water without boots where ore with mercury is washed
- Miners inhale vapours without a protective mask or are at risk of contaminated water splashing in their eyes
- During amalgamation, the mercury contaminates the water and soil it encounters, entering the local water sources and environment

Image 12 : Mercury exposure occurs when touching it with bare hands.

DURING OPEN BURNING

- When heated and burned, mercury gives off extremely dangerous vapours
- Miners who heat and burn amalgam openly, inhale the vapours and poison themselves
- This vapour enters the air and sticks to the miner's clothes, as well as buildings, nearby objects, and can travel into the community through the air where other family members can inhale it
- If mercury is burned on household pots or in household cooking areas, it contaminates those surfaces and exposes family members to mercury poisoning

Image 13 : When heated and burned, mercury gives off extremely dangerous vapours.

DURING PROCESSING

- Direct contact with liquid mercury exposes the miner to poisoning, contaminating the environment, as well as releasing vapours into the air
- Mercury is often incorrectly used during processing exposing many people in the processing area to mercury poisoning
- Mercury use during whole ore amalgamation leads to significant contamination of the environment, and the release of vapours. Worst and unsafe practices include:
  - Adding mercury to the mat of a sluice and the whole ore passed over mercury
  - Adding mercury to centrifugal concentrators with ore passing through the equipment and mixing with mercury
  - Adding mercury to wet pan mills and grinding the ore mixed with mercury

Image 14 : Unsafe practice includes adding mercury to the mat of a sluice.

Image 15 : Unsafe practice includes adding mercury to a centrifugal concentrator.

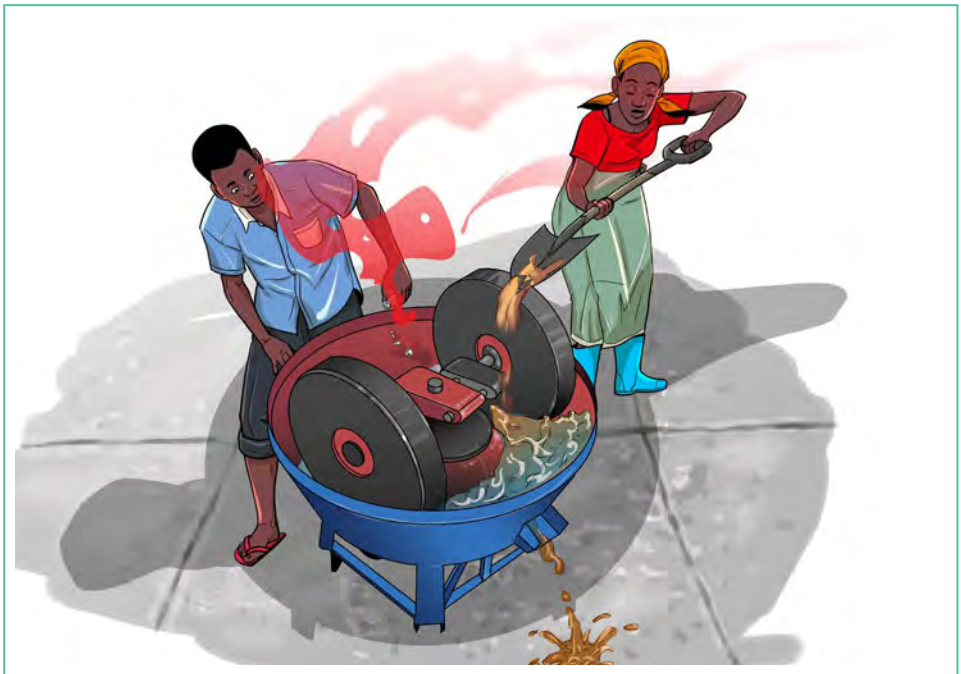

Image 16 : Unsafe practice includes adding mercury to a wet pan mill.

DURING AMALGAM BURNING AND SMELTING

- When heated and burned, mercury gives off extremely dangerous vapours
- During smelting, residual mercury is released off the sponge gold
- Gold traders, buyers or miners who heat and burn the gold openly to clean the gold, inhale the vapours and poison themselves and others
- This vapour enters the air and sticks to the clothes, as well as buildings, nearby objects, and can travel into the community through the air where other people can inhale it

Image 17 : When heated and burned, mercury gives off extremely dangerous vapours.

Contaminating the Environment

During its use, mercury vapour travels in the air and can end up in different surfaces including on soil and water. Using liquid mercury in water or in the ground that is unlined and unprotected allows the mercury to enter the local water sources and soil.

Image 18 : Mercury contaminates the water, soil, and air.

Once mercury enters the local water and soil it contaminates the local environment. Anyone drinking the water is poisoned with mercury. Fish that live in the water or livestock that depend on the water, are contaminated with mercury. If local communities eat those fish or animals, they are in turn poisoned.

If mercury seeps into the soil, it affects the local biodiversity and plants that animals and people eat such as potatoes, tomatoes, and bananas.

ACTIVITY

As a group or divided into two groups, map the mine site and different supply chain activities. Identify everywhere that mercury is stored, handled, or used. Discuss how mercury harms miners, their families, communities, and the environment at each point. Discuss how family members and local communities are exposed to mercury.

As a group, discuss the following questions:

1. Where is amalgam currently burned and using what type of tools? If at home and using cooking utensils, discuss why it's dangerous and what can be done to stop it.

2. How can you raise awareness about the risks associated with mercury at your mine site and across the community?

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IMPACT transforms how natural resources are managed in areas where security and human rights are at risk. We investigate and develop approaches for natural resources to improve security, development, and equality. We are an independent non-profit, collaborating with local partners for lasting change.
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The **planetGOLD Uganda** project aims to reduce the use of mercury by supporting formalization of the artisanal gold mining sector and increasing access to finance. This will lead to adoption of mercury-free technologies and allow access to more responsible and traceable gold supply chains. The project is supported by the Global Environment Facility, led by the UN Environment Programme, executed by IMPACT in partnership with Uganda's National Environment Management Authority and the country's Ministry of Energy and Mineral Development under the Department of Mines.
www.planetgold.org/uganda

The **planetGOLD Côte d'Ivoire** project aims to reduce the use of mercury in the artisanal gold mining sector through a holistic, multi-sectoral and integrated formalization approach. The project also aims to improve access to traceable gold supply chains and financing for the adoption of sustainable, effective and practical mercury-free technologies. The project is supported by the Global Environment Facility, led by the UN Environment Programme, executed by the Centre Africain pour la Santé Environnementale (CASE) and IMPACT.
www.planetgold.org/cote-divoire

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MODULE 6:
SAFER HANDLING OF MERCURY

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Learning Outcomes

BY THE END OF THIS SESSION, PARTICIPANTS SHOULD:

- Understand safer ways of working with mercury, including:
  - Proper equipment to wear
  - How to store mercury
  - How to limit exposure for themselves and others
- Understand where and how to create dedicated mercury use areas
- Understand the different tools to limit mercury exposure
- Be able to build and use a kitchen bowl retort

NOTE TO THE FACILITATOR

It is recommended that this training should be completed by someone who is familiar with artisanal gold mining techniques and has had previous training on the equipment presented within this module.

While the training offers learning and discussion, it should be accompanied by demonstrations of the equipment and hands-on learning. It is recommended that the training take place near or at a mine site.

Any demonstrations with mercury must be handled in a safe and secure manner, following all proper safety recommendations. Where possible, it is suggested a non-toxic substitute to mercury is used.

Safer Handling of Mercury

Mercury is a poison. Using mercury in mining can result in health problems for the miners as well as the surrounding community. Using mercury carelessly at mining sites and in homes can contaminate the environment and lead to health problems for miners, their families, and the community.

How mercury pollutes the environment:

- Improper storage or disposal of mercury-contaminated tailings can pollute water sources, biodiversity such as fish or livestock, food crops such as potatoes, tomatoes, bananas.
- Improper storage of unused mercury leads to exposure of poisonous vapours.
- Whole ore amalgamation and disposal of mercury in tailings can contaminate environment and air.
- Use of mercury in gold extraction such as open burning of amalgam leads to release of vapours.

Image 1 : Using mercury in mining can contaminate the environment and air.

Image 2 : Use of mercury in gold extraction such as open burning of amalgam leads to release of vapours.

The ideal solution is to eliminate the use of mercury in gold artisanal and small-scale mining (ASM). However, mercury is still commonly used in the sector for gold recovery. While miners implement mercury-free technologies, it is important that they understand the risks of mercury use and adopt safer handling practice to minimize environmental contamination and health risks.

Through safe practices in working with mercury, miners can protect themselves, their families, and their communities from mercury poisoning. This includes:

- Properly disposing mercury-contaminated tailings by burying them in a lined pit, away from water sources and areas prone to flooding.
- Using proper retorts in designated areas and fume hoods in gold shops to capture and recycle mercury.
- Wearing appropriate protective clothing when working with mercury.

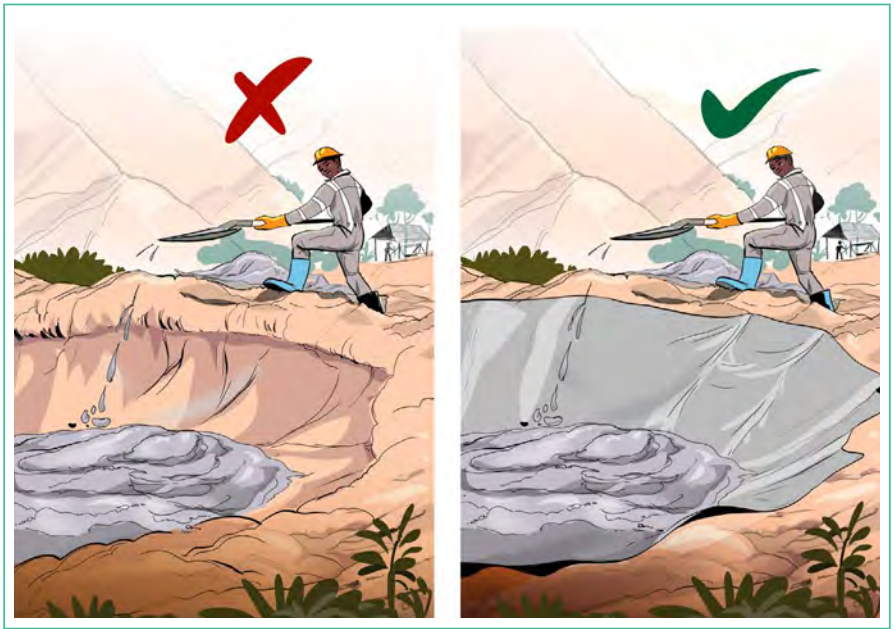

Image 3 : Properly dispose of mercury-contaminated tailings by burying them in a lined pit.

To address the risks with mercury, miners should be trained on safe ways of handling of mercury.

NOTE TO THE FACILITATOR

Ahead of the training, the trainer should research and become informed about mercury use in the area, as well as locally available equipment for safer handling.

Protection Against Mercury Exposure

Personal Protective Equipment

Miners should use Personal Protective Equipment (PPE) when using mercury. This can be provided by mine site management, site owners, mining groups, or miners themselves. The PPE should be worn properly and maintained in good condition and replaced when needed.

THE KEY PPE ITEMS TO REDUCE MERCURY EXPOSURE

- Respirators or face masks to filter out mercury vapors. The respirators should be those approved by National Regulatory Agencies for Occupational Safety and Health, or those from reputable suppliers who comply with national standards. The respirators should be worn whenever miners are handing mercury, especially during the amalgamation process.
- Gloves to avoid skin contact with mercury.
- Protective clothing, such as overalls or aprons, to prevent mercury from contaminating regular clothes.
- Eye protection such as goggles to prevent mercury splashes in the eyes.
- Boots to avoid tracking mercury-contaminated dust into living areas.

Image 4 : Respirators or face masks filter out mercury vapors.

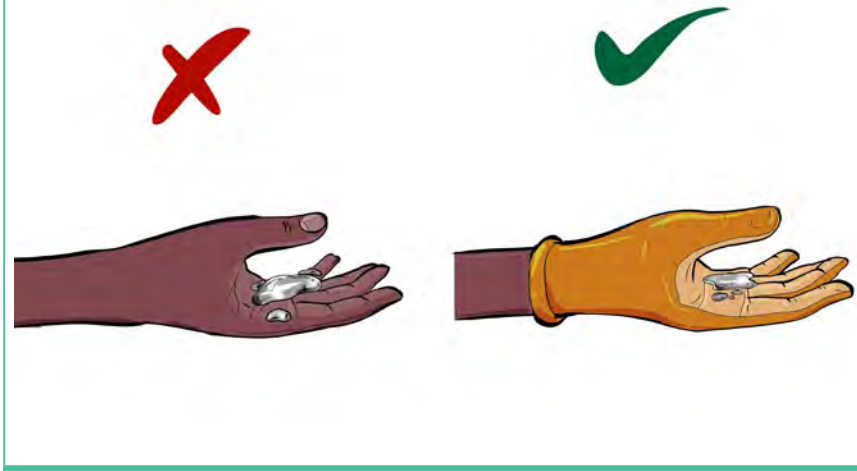

Image 5 : Gloves avoid skin contact with mercury.

Image 6 : Protective clothing prevent mercury from contaminating regular clothes.

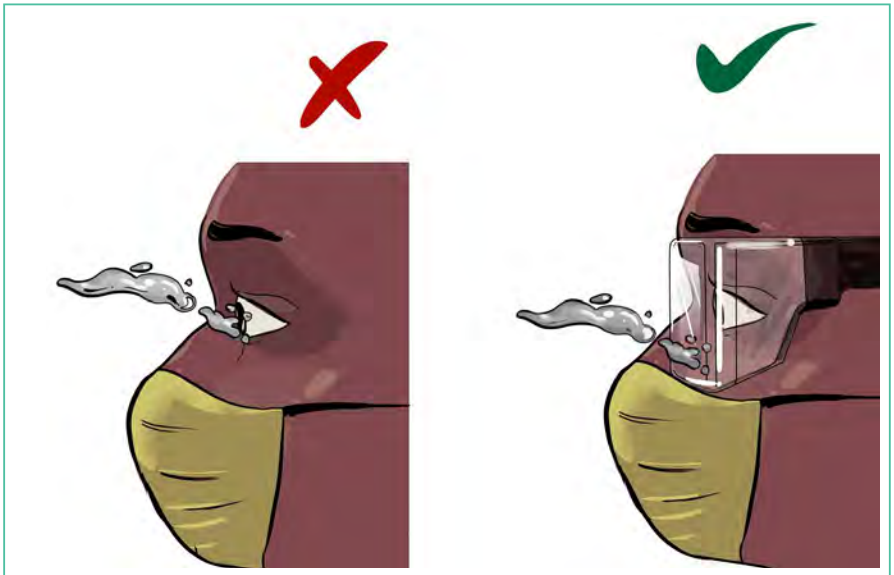

Image 7 : Wear eye protection, such as goggles, to prevent mercury splashing in the eyes.

PROPER USE AND MAINTENANCE OF PPE

- Ensure that all PPE is in good condition and fits the user properly
- Train miners on the correct way to wear, use, and maintain their PPE
- Regularly inspect and replace PPE as needed to maintain its effectiveness
- Properly store and dispose of used or damaged PPE to prevent further contamination

Image 8 : Ensure that all PPE is in good condition and fits the user properly.

Image 9 : Train miners on the correct way to wear, use, and maintain their PPE.

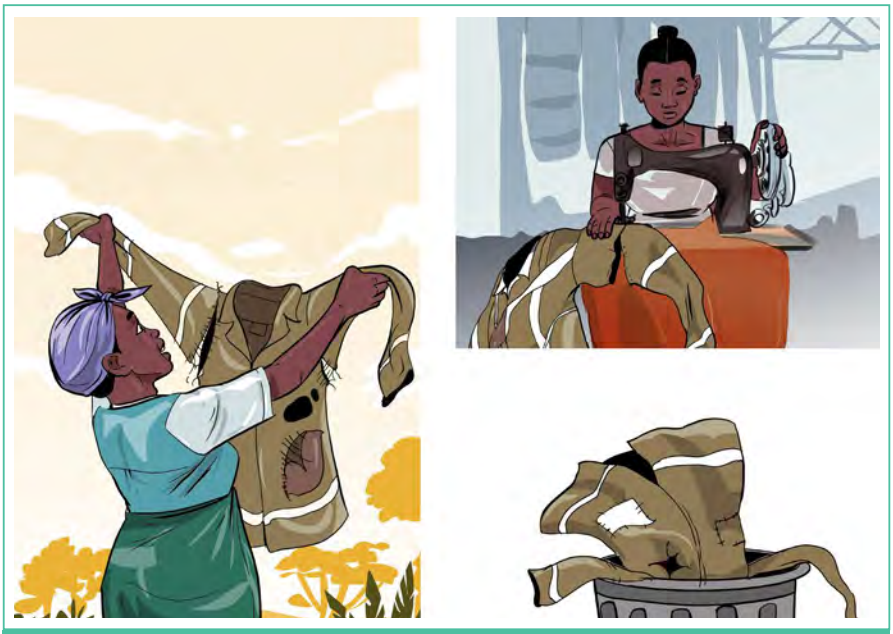

Image 10 : Regularly inspect and replace PPE as needed to maintain its effectiveness.

Tips for Miners When Working with Mercury

Awareness of the dangers of not using or improperly using PPE when working with mercury is extremely important.

- If miners' clothing is polluted with mercury, they should change into clean clothes before leaving the working area
- Contaminated clothing should be properly stored and cleaned
- Miners who have skin contact with liquid mercury should immediately and thoroughly wash exposed body surfaces with soap or a mild detergent and water
- Preparing food, eating, drinking and smoking should not be permitted in areas where mercury is used or stored
- Miners who use or are exposed to mercury should wash their hands thoroughly with soap or mild detergent and water before preparing food, eating, smoking, or using toilet facilities

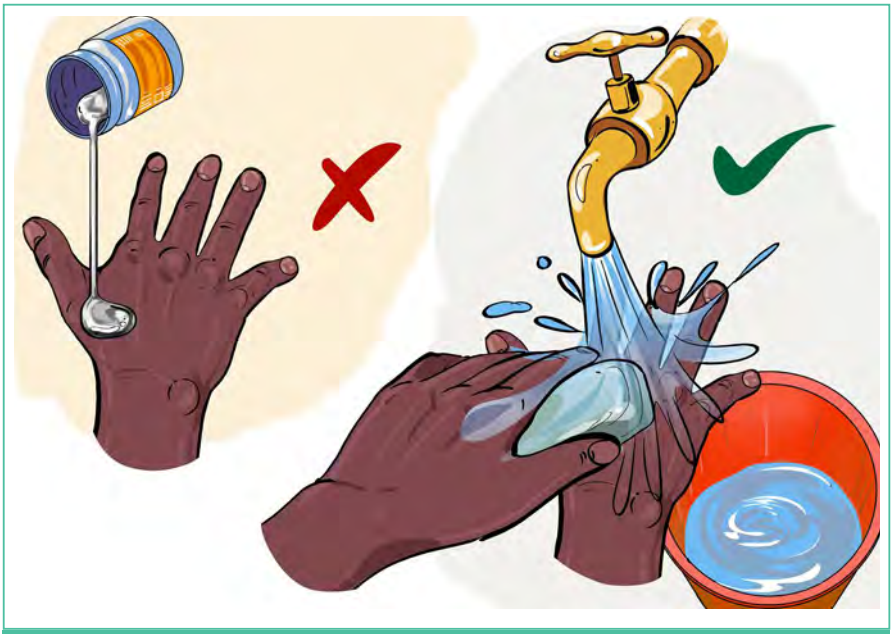

Image 11 : Miners who have skin contact with liquid mercury should immediately and thoroughly wash exposed body surfaces with soap or a mild detergent and water.

Image 12 : Preparing food, eating, drinking and smoking should not be permitted in areas where mercury is used or stored.

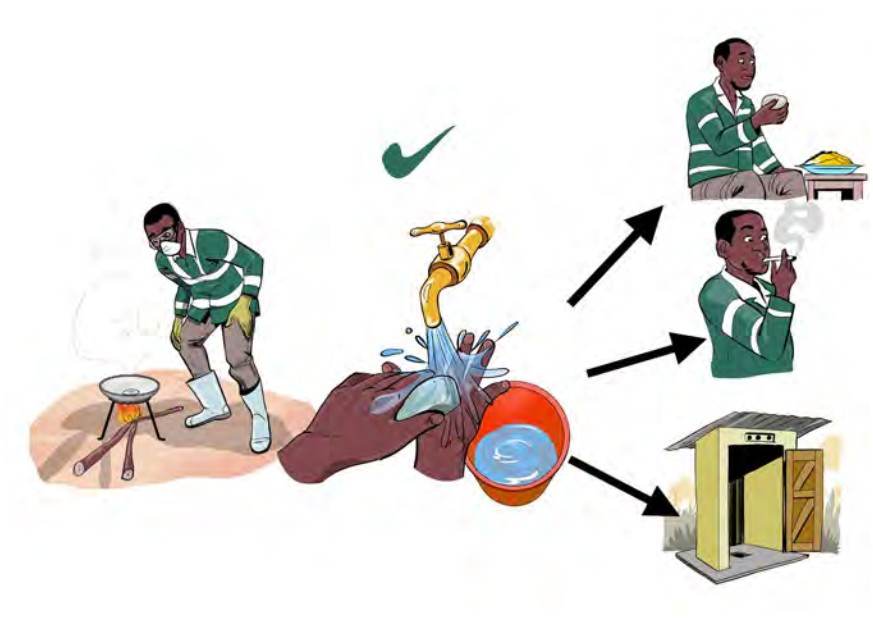

Image 13 : Miners who use or are exposed to mercury should wash their hands thoroughly with soap or mild detergent and water before preparing food, eating, smoking, or using toilet facilities.

Remember, it is the responsibility of a miner to ensure that they are safe from workplace accidents and diseases. The government is responsible for providing and enforcing workplace policies applicable to the ASM sector. The mining groups and mining leadership support and give guidance on implementation and compliance with the ASM workplace policies, for example providing PPE and ensuring it is worn.

Limiting Exposure to Vapour

Mercury can release harmful mercury vapours. To limit the spread of its vapours, the following guidelines on mercury storage and handling should be followed:

- Mercury should be stored in closed airtight containers covered with a centimetre of water to prevent evaporation
- Cover the mercury with a thin layer of water (about 1cm) to prevent evaporation
- Never store mercury in residential areas

- Keep mercury in a secure, well-ventilated location away from populated areas.
- Mercury can be reused. When its effectiveness decreases, it can be recharged.
- Do not dump mercury on the ground or in water.
- Adhere to safe handling and storage protocols for mercury in the artisanal gold mining sector to protect the health of miners and prevent environmental contamination.

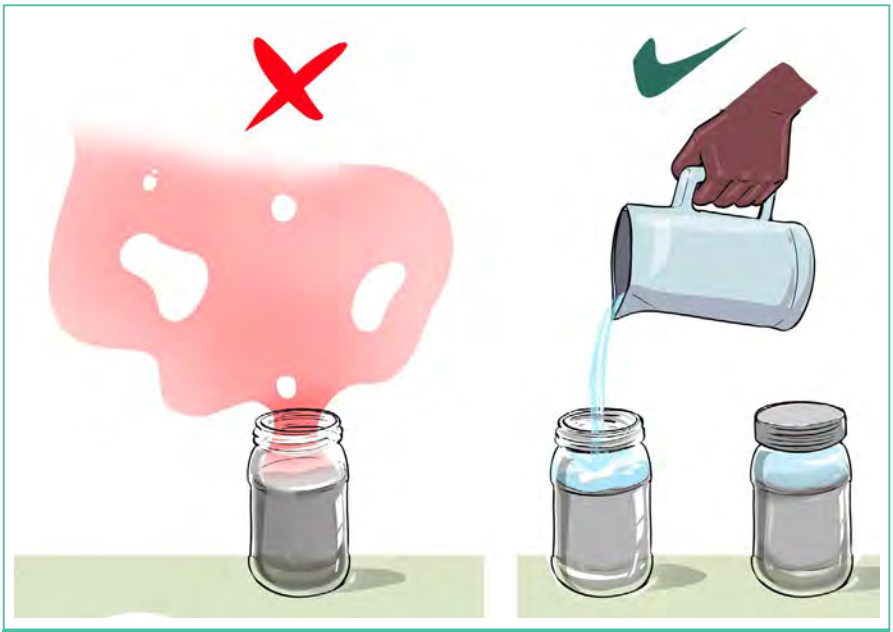

Image 14 : Mercury should be stored in closed airtight containers covered with a centimetre of water.

Image 15 : Do not dump mercury on the ground or in water.

Protecting Children and Pregnant Women

Mercury is highly dangerous for unborn babies, children, and women of child-bearing age. Children and pregnant women should not participate and be removed from all mercury-related activities including:

- Ore processing
- Amalgam burning
- Mercury storage

Image 16 : Children and pregnant women should not participate and be removed from all mercury-related activities.

PREGNANT WOMEN AND CHILDREN COULD BE PROTECTED BY

- Creating safe zones for children to play under supervision away from ASM sites.
- Educating mining communities, especially families, on the dangers of mercury exposure for children and pregnant women.
- Where possible developing and implementing policies to prevent the involvement of children and pregnant women in mercury use and storage.

It is strongly discouraged to involve children or pregnant women in mercury use.

ACTIVITY

Divided into two groups, role play the correct and incorrect ways of storing and handling mercury:

1. Provide the groups with a set of materials: an airtight container, water, and a small amount of mercury (simulated using a safe alternative).

2. Have each group present how they intend to store the mercury and where and explain the reasoning.

3. Discuss as a group and provide feedback.

As a group, discuss the following questions:

1. Do you or other miners wear PPE when working with mercury? Why or why not?

2. How is mercury currently handled or stored? Why?

3. What are possible steps you can take to reduce mercury exposure to yourself and others?

4. Are pregnant women and children currently exposed to mercury at your mine site?

5. Why should mercury be stored in an airtight, unbreakable container?

6. What can happen if you store mercury at home? What if you dump it on the ground or in the water?

7. How can the risk of mercury exposure (for yourself and others) be decreased?

Establishing Dedicated Mercury Use Locations

The amalgamation area should consist of the retort area, amalgamation ponds and area to discharge tailings containing mercury.

The area should be close to the processing area and far from any residences. Miners should not be allowed to carry amalgam out of the processing area to limit the spread of mercury and its vapours.

CHOOSING APPROPRIATE LOCATIONS FOR MERCURY USE

Amalgamation and retorting should only be conducted in designated sites (amalgamation area and isolated retorting places) at least 500m from any inhabited place where feasible. However, as most artisanal gold mine sites are highly populated, the main consideration is that it should be a reasonable distance from people and operations, not facing the direction of the wind.

- For any mining location where amalgamation occurs, miners, the mine owner or mine manager should designate a portion of the mining location as the prescribed structure, facility or locale where amalgamation may take place. Amalgamation should only take place in the selected area.
- Mercury should never be used near homes, schools, or other populated areas. The area should be a reasonable distance from areas with people (ideally at least 500m).
- Mercury should also never be used near rivers, streams, lakes, or other water bodies. The area should be at least 100m away from any water sources. While this is the standard, miners should identify reasonable distances that will limit discharge of mercury to the rivers and streams.
- Mercury should be used in a flat, open area that is easy to clean and has good ventilation. Avoid using mercury in enclosed spaces. Amalgamation areas should provide open circulation of ventilation air.

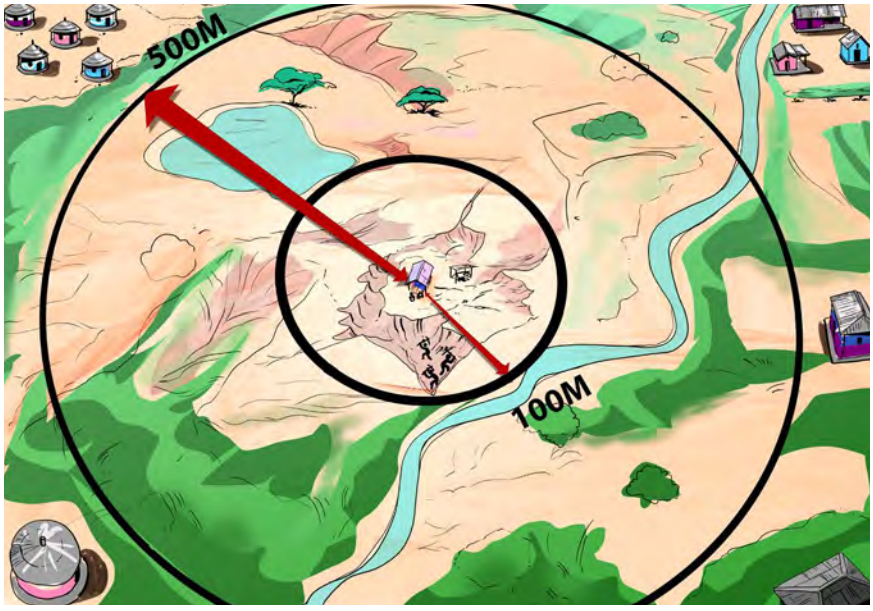

Image 17 : Amalgamation and retorting should only be conducted in designated sites at least 500 m from any inhabited place and 100 m from any water sources.

Amalgamation Ponds

Amalgamation ponds are designated areas for amalgamating gold concentrates with mercury. This helps capture the gold while preventing mercury from spreading.

- Miners should build the amalgamation pond with concrete or plastic lining to prevent mercury from leaking into the soil and groundwater.
- The pond should have sloped sides to make it easy to access and clean.
- It should also have a cover to prevent rain or wind from blowing mercury particles away.
- When the amalgamation is complete, the mercury-gold amalgams should be carefully scooped out and the tailings kept separately from the rest for proper disposal or removal of mercury.
- The pond should not be discharged directly into the environment.

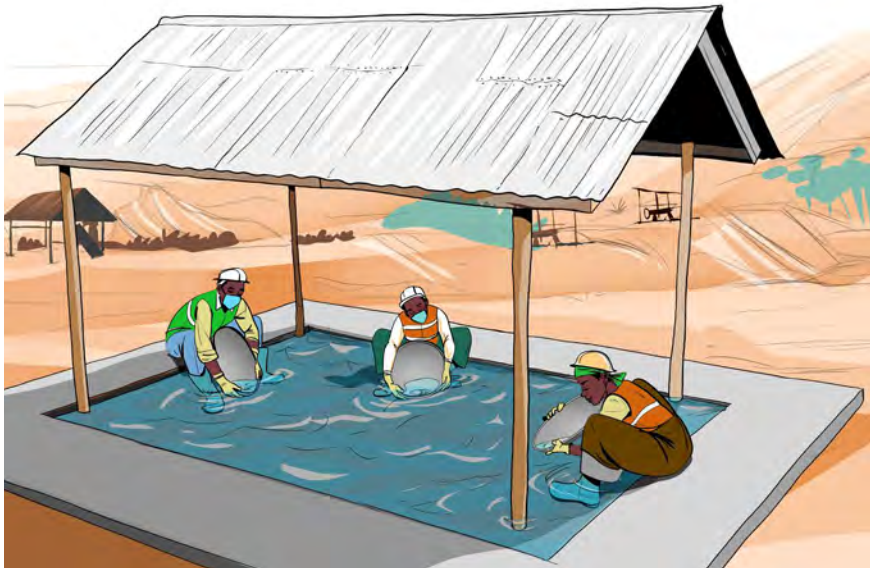

Image 18 : Amalgamation pond.

ACTIVITY

As a group, discuss the following questions:

1. Does your mine site have dedicated areas for mercury use?

2. Are the areas in the correct locations and are they used properly?

3. How can you introduce dedicated areas for mercury use and ensure they are used?

4. How can dedicated mercury use areas be improved upon?

Retorts

Open-air amalgamation is a practice that should be avoided as it allows mercury vapour to easily escape and disperse into the surrounding air thereby contaminating the environment. To avoid the hazards of open burning, miners can use a retort to capture and recycle the mercury from the amalgam.

NOTE TO THE FACILITATOR

The training should include a demonstration of how retorts work. This activity should only be undertaken in a safe and well-ventilated environment, appropriate for mercury use. All participants and trainers should wear appropriate PPE. Where possible, simulated mercury-gold amalgam (a non-toxic substitute) should be used instead of mercury.

INSTRUCTIONS:

1. Set up a demonstration area with a kitchen bowl retort and appropriate safety equipment (e.g., heat-resistant gloves, goggles, face mask).
2. Provide the trainees with a small amount of mercury-gold amalgam or simulated mercury-gold amalgam where available.
3. Guide the trainees through the steps of loading the amalgam into the retort vessel, sealing the system, and heating the retort.
4. Observe the trainees as they monitor the retorting process, watch the mercury vapor condense in the tube, and collect the recovered mercury in the collection container.
5. Discuss the importance of following the correct procedures and the benefits of using a retort compared to open burning of the amalgam.

A retort is a special equipment to safely remove the mercury from the air before it is released into the environment. The retort captures the mercury vapour and it condenses to liquid mercury that can be recovered and reused.

THE BENEFITS OF USING MERCURY RETORTS IN ARTISANAL GOLD MINING

- Using a retort is a simple and affordable way to protect yourself and your community from the dangers of mercury as it reduced mercury emissions.
- Capturing and recycling mercury can be an effective first step in moving towards mercury-free processing.
- Simple and affordable models can reduce mercury emissions by 75 to 95%.
- Recycling mercury prevents the need for fresh mercury imports, saving miners money.
- This can lower costs for miners and gold shops by reducing mercury consumption.
- There is no gold loss that occurs when using retorts.

The Kitchen Bowl Retort

There are many types of retorts used in mining communities. The kitchen bowl retort provides a simple and inexpensive example of a retort that miners can fabricate at home. The kitchen bowl retort can be made with metallic and glass bowls found locally at the market.

Image 19 : Kitchen bowl retort.

HOW IT'S MADE

1. A large steel or enamel bowl with a hole cut at the bottom. The size of the hole depends on the available material and scale of operation.
2. A small stainless steel or enamel bowl to hold the amalgam (it fits into the hole made in the large metallic bowl). Once the stainless-steel bowl is inserted into position, the bowl is filled with wet sand all around.
3. A glass bowl to be used as a cover (glass bowls are good for as miners can see and monitor the process). These will be good if they can be found easily in the local market and affordable. Stainless steel or enamel bowls work just as well.
4. A metallic support to hold the bowls (this can be replaced with 3 stones) or any support that allows heat introduced to the small bowl or cup holding the amalgam.
5. Once the mercury evaporates it condenses and flows down the glass bowl and drops on the sand. After a few runs, the sand can be panned to recover the mercury for re-use.

HOW IT WORKS

- The hole in the bottom of the bowl is for direct heat for the amalgam with the source of heat or fire.
- A bowl made of stainless steel or enamelled steel makes the gold not stick.
- The amalgam placed in the small bowl is heated by a bonfire, a kerosene stove or a blowtorch (propane or butane). The fire intensity should be increased for effective retorting.
- Mercury evaporates and condenses on the walls of the glass cover, dripping onto the sand.
- The sand in the bowl must be wet to make a seal that prevents loss of mercury vapor. The moisture in the sand also speeds up the condensation of mercury vapor.
- A wet towel can also be used to cool the glass cover
- A glass cover at the first operations will show the miners how the retort works. The glass cover takes a longer time to cool down compared to enamel cover. However, it provides for visual observation during the process.
- The advantage of the steel bowl is that:
  - The cover cools down very fast
  - It is cheaper than a glass bowl
  - It is hard to break
- After retorting, the sand can be panned to recover the mercury.

Classic Retort

The classic retort can be implemented once miners are regularly using a kitchen bowl retort. It is a more advanced mercury-retorting device than the kitchen bowl retort. It is designed to effectively separate and recover mercury from gold-mercury amalgam, while also reducing the release of mercury vapor into the environment. The classic retort may be more costly, however also provides more protection since it is airtight.

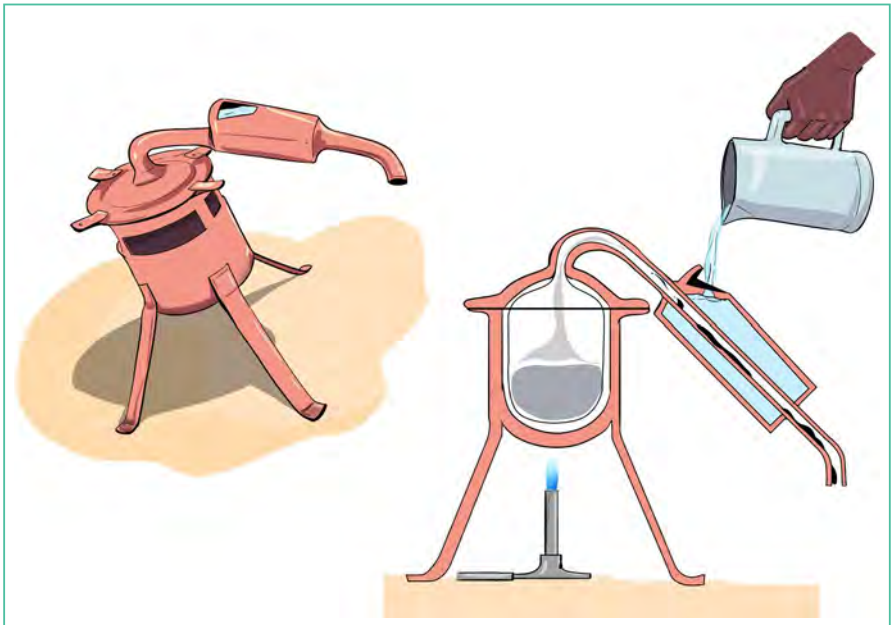

Image 20 : Classic retort.

THE KEY COMPONENTS OF A CLASSIC RETORT TYPICALLY INCLUDE

1. Retort Vessel (crucible): This is the main chamber where the mercury-gold amalgam is placed. It is usually made of heat-resistant materials like stainless steel or cast iron.
2. Condensing Tube: This is a long, sometimes curved tube that connects the retort vessel to the collection container. The condensing tube allows the mercury vapor to cool and condense, enabling the recovery of liquid mercury.
3. Collection Container: This is the container where the condensed mercury is collected and stored for reuse. It is often designed with a sealed lid to prevent mercury vapor from escaping.
4. Heat Source: Classic retorts use an external heat source, such as a furnace, electric heater, or even a charcoal or wood fire, to heat the retort vessel. The heat causes the mercury to vaporize, separating it from the gold.

THE OPERATION OF A CLASSIC RETORT INVOLVES THE FOLLOWING STEPS

- The mercury-gold amalgam is placed in the retort vessel.
- The retort vessel is sealed, and the condensing tube is connected to the collection container.
- The heat source is activated, causing the mercury to vaporize.
- The mercury vapor travels through the condensing tube, where it cools and condenses into liquid mercury, which is collected in the container.
- The recovered mercury can then be reused in future amalgamation processes.

THE KEY ADVANTAGES OF A CLASSIC RETORT

- Classic retorts are designed to efficiently capture and recover mercury, reducing the amount of mercury lost or released into the environment.
- The enclosed design and condensing system help to minimize the release of mercury vapour, protecting the health of miners and the surrounding community.
- The recovered mercury can be reused in the amalgamation process, reducing the need for new mercury purchases and further minimizing environmental impacts.

Retort Safety

While retorts reduce the amount of mercury exposure, some mercury vapour escapes into the air when using even the most effective retort. Proper training and maintenance are essential for the safe and effective use of retorts in ASM operations.

SAFETY TIPS

- The operator of the retort is encouraged to always use appropriate PPEs.
- Once a retort or fume hood (see below) is used, it becomes contaminated with mercury and must be maintained with care.
- Retorts and fume hoods should be kept in a secure space and precautions must be taken if they are transported inside cars or in backpacks to prevent exposure.
- Retorts should never be operated by children or by pregnant women.
- They should only be used in very well-ventilated areas, preferably outdoors or inside of a fume hood.
- Use wet sand to make a seal that prevents the loss of mercury vapor.
- Retorts should not be opened until they have cooled, otherwise mercury vapour can escape into the environment.

REMEMBER

- Always use a retort when burning the mercury-gold amalgam. Retorts capture and condense the mercury vapours, allowing you to reuse the mercury.
- Burn the amalgam in an open, outdoor area at a safe distance from any buildings or people. Never burn amalgam indoors.
- Do not allow children or pregnant women near the retorting area.

ACTIVITY

As a group, discuss the following questions:

1. Are retorts currently used at your mine site?

2. How does a retort help to mitigate the risks of mercury exposure and environmental contamination? What are the benefits of using a retort?

3. What steps should be taken to ensure the safe and effective use of a retort?

4. How can the recovered mercury from the retorting process be reused, and what are the advantages of this practice?

5. How can retorts become more widely used within your mine site?

Fume Hoods

Fume hoods provide a physical barrier between the user and the mercury-contaminated air. They can be used for large volumes of amalgam or when multiple users want to burn their amalgam such as in gold shops.

Mercury amalgamation fume hoods are often designed with additional features to optimize their performance in the artisanal gold mining context. These fume hoods are designed and constructed to meet specific safety standards and regulations for the handling and containment of mercury in the sector. They help miners and gold processors comply with environmental and occupational health requirements related to mercury use and emissions. Proper installation, maintenance, and operator training are essential for the effective and safe use of mercury amalgamation fume hood.

Using a fume hood, mercury is recovered and can be recycled, re-used, or re-sold to reduce overall mercury consumption. Fume hoods are potential tools for mining groups with many miners or gold buyers, as they can capture and recycle mercury, reduce mercury pollution, and decrease associated health risks.

Fume hoods would be relevant for users, such as gold buyers, who have a specific location where they want to process the gold as the fume hoods cannot be transported. The construction of fume hoods is complicated, requiring installation, and long-term use in one location—versus the retort which can be easily transported.

Proper PPE is required when using a fume hood.

ACTIVITY

As a group, discuss the following questions:

1. What context would a fume hood be most applicable in?

2. Who potentially could use a fume hood? How can you encourage its use?

Mercury Recharging

When mercury has been used repeatedly it becomes oxidized and does not amalgamate effectively. To recharge it, the mercury is immersed into a plastic container with 10% of table salt (or a household plastic cup with a solution of 1 tablespoon of salt). Using a 12V battery, the negative charge is connected to the mercury immersed in water, while the positive charge is connected to the solution. After 10-20 minutes, the mercury will be recharged and should be used before 1-hour elapses as it loses its recharge.

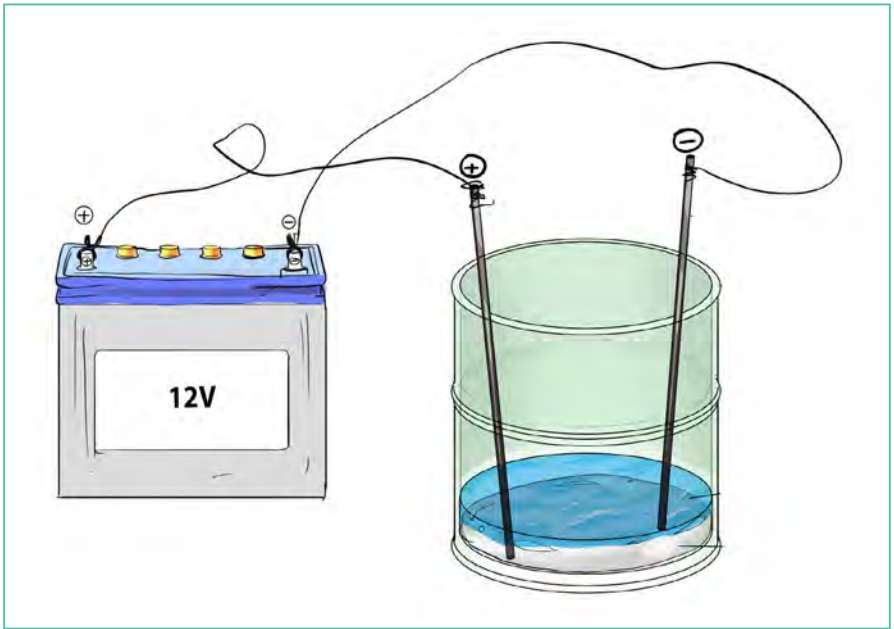

Image 21 : Mercury recharging.

ACTIVITY

Conduct an exercise to recharge mercury and have participants share their observations. Caution should be taken in handling mercury.

Involving the Local Community in Reducing Mercury

Reducing mercury use and exposure to mining communities needs everyone to work together. Involve the whole community - other miners, community leaders, women's groups, health workers, and environmental groups.

HERE ARE SOME WAYS TO ENGAGE THE COMMUNITY

- Have meetings to discuss the health and environmental risks of mercury and get input on solutions.
- Partner with community leaders to spread awareness and encourage behaviour changes.
- Work with women's groups to educate other women miners on safe mercury practices.
- Work with health clinics to monitor mercury exposure and provide treatment.

ACTIVITY

As a group, discuss the following questions:

1. What are the advantages to involving the local community in reducing mercury use?

2. What steps can be taken to involve the community in reducing mercury use?

Resources Available

VIDEO:
PPE: Protection for Your Future
Learn what Personal Protective Equipment (PPE) you should be wearing at an artisanal mine site and why.

English : https://bit.ly/IMPACTPPE_VideoEN
French : https://bit.ly/IMPACTPPE_VideoFR
Baoule : https://bit.ly/IMPACTPPE_VideoBaoule
Dioula : https://bit.ly/IMPACTPPE_VideoDioula
Djimin : https://bit.ly/IMPACTPPE_VideoDjimini
Senoufo : https://bit.ly/IMPACTPPE_VideoSenoufo

VIDEO:
Mercury: Protect Yourself, Your Family, and the Environment
Learn about the dangers of working with mercury in artisanal gold mining, and how to mitigate some of its harmful effects.

English : https://bit.ly/IMPACTMercuryDangers_VideoEN
French : https://bit.ly/IMPACTMercuryDangers_VideoFR
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Dioula : https://bit.ly/IMPACTMercuryDangers_VideoDioula
Djimin : https://bit.ly/IMPACTMercuryDangers_Djimini
Senoufo : https://bit.ly/IMPACTMercuryDangers_VideoSenoufo

BROCHURE:
Mitigating the Dangers of Mercury
How to protect yourself when using or handling mercury.

English : https://bit.ly/IMPACTMercuryDangers_BrochureEN
French : https://bit.ly/IMPACTMercuryDangers_BrochureFR
Swahili : https://bit.ly/IMPACTMercuryDangers_BrochureSwahili
Luganda : https://bit.ly/IMPACTMercuryDangers_BrochureLuganda

POSTER:
Handling Chemicals Safely
10 steps to protect yourself and others when using chemicals such as mercury in mining and processing.

English : https://bit.ly/IMPACTPosterHandlingChemicals_EN
French : https://bit.ly/IMPACTPosterHandlingChemicals_FR
Swahili : https://bit.ly/IMPACTPosterHandlingChemicals_Swahili
Luganda : https://bit.ly/IMPACTPosterHandlingChemicals_Luganda

IMPACT
Transforming natural resource management
Empowering communities

planetGOLD Uganda

planetGOLD Côte d'Ivoire

IMPACT transforms how natural resources are managed in areas where security and human rights are at risk. We investigate and develop approaches for natural resources to improve security, development, and equality. We are an independent non-profit, collaborating with local partners for lasting change.
www.impacttransform.org

The **planetGOLD Uganda** project aims to reduce the use of mercury by supporting formalization of the artisanal gold mining sector and increasing access to finance. This will lead to adoption of mercury-free technologies and allow access to more responsible and traceable gold supply chains. The project is supported by the Global Environment Facility, led by the UN Environment Programme, executed by IMPACT in partnership with Uganda's National Environment Management Authority and the country's Ministry of Energy and Mineral Development under the Department of Mines.
www.planetgold.org/uganda

The **planetGOLD Côte d'Ivoire** project aims to reduce the use of mercury in the artisanal gold mining sector through a holistic, multi-sectoral and integrated formalization approach. The project also aims to improve access to traceable gold supply chains and financing for the adoption of sustainable, effective and practical mercury-free technologies. The project is supported by the Global Environment Facility, led by the UN Environment Programme, executed by the Centre Africain pour la Santé Environnementale (CASE) and IMPACT.
www.planetgold.org/cote-divoire

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UN environment programme

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IMPACT
Transforming natural resource management
Empowering communities

planetGOLD Uganda

planetGOLD Côte d'Ivoire

MODULE 7:
TECHNIQUES TO ELIMINATE MERCURY

FACILITATOR'S GUIDE

Supporting Best Practices at Artisanal Gold Mines Toolkit

Supported by gef

Led by UN environment programme

In partnership with Canada

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Learning Outcomes

BY THE END OF THIS SESSION, PARTICIPANTS SHOULD:

- Understand the difference between mercury reduction and elimination
- Demonstrate how to reduce mercury in processing
- Identify the right equipment for mercury-free processing
- Demonstrate basic mercury-free processing techniques

NOTE TO THE FACILITATOR

It is recommended that this training should be completed by someone who is familiar with artisanal gold mining techniques and has had previous training on the equipment presented within this module.

While the training offers learning and discussion, it should be accompanied by demonstrations of the equipment and hands-on learning. It is recommended that the training take place near or at a mine site.

Any demonstrations with mercury must be handled in a safe and secure manner, following all proper safety recommendations. Where possible, it is suggested a non-toxic substitute to mercury is used.

From Reduction to Mercury Elimination

While mercury is widely used across artisanal gold mines, miners should make efforts to reduce and eliminate it from their mine site. In Module 6: Safer Handling of Mercury demonstrates how to make working with mercury safer where conditions do not yet allow for its elimination or where access to advanced techniques to eliminate it is not yet possible.

Mercury-free equipment can be expensive and difficult to acquire. However, there are many basic strategies miners can use that are low cost and locally available to reduce and eliminate mercury from processing. These are the techniques presented in this module.

Reducing Mercury

Reducing mercury used requires that miners amalgamate only the concentrate. By doing this, miners stop whole ore amalgamation. Whole ore amalgamation is classified as a worst practice under the Minamata Convention.

If mercury is added during whole ore amalgamation, it leads to significant contamination of mining materials and environment, as well as the release of vapours.

WHOLE ORE AMALGAMATION INCLUDES

- Adding mercury to the mat of a sluice box and the whole ore passing over mercury
- Adding mercury to concentrators with ore from the mill passing through the equipment with mercury
- Adding mercury to wet pan mills and grinding the ore mixed with mercury

Image 1 : Unsafe practice includes adding mercury to the mat of a sluice.

Image 2 : Unsafe practice includes adding mercury to a centrifugal concentrator.

Image 3 : Unsafe practice includes adding mercury to a wet pan mill.

During whole ore amalgamation, a miner uses 3-10 grams of mercury for 1 gram of gold. A lot of the mercury is lost to tailings.

By moving away from whole ore amalgamation and only to concentrate amalgamation, the amount of mercury is significantly decreased: 1 gram of mercury for 1 gram of gold. This means adding mercury only during the last stage of gold recovery after concentration or sluicing.

This results in:

- Miners requiring less mercury
- Miners spending less money on mercury and increasing their income
- Miners having larger profits
- Less mercury contamination and exposure

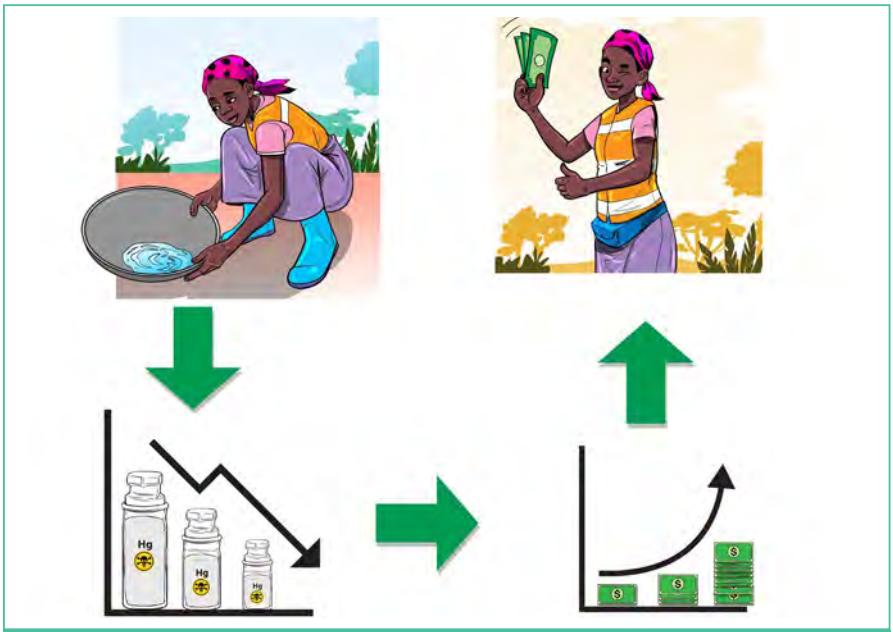

Image 4 : Adding mercury only in last stage of gold recovery results in more profits.

Moving Towards Elimination

As miners move away from the worst practices of mercury handling and learn about its dangers, they move towards the path of elimination.

WORST PRACTICES	IMPROVED PRACTICES
Whole Ore Amalgamation	Add mercury only to concentrates
Open Burning Of Amalgam	Use retorts to capture mercury vapour and reuse mercury
Burning Amalgam In Residential Areas	Processing mercury in designated work areas away from residential areas
Mixing Mercury With Local Water Sources.	Using designated amalgamation pond lined with concrete or plastic
Adding Cyanide To Mercury-Containing Tailings.	Removing mercury from mercury-containing tailings before applying cyanide

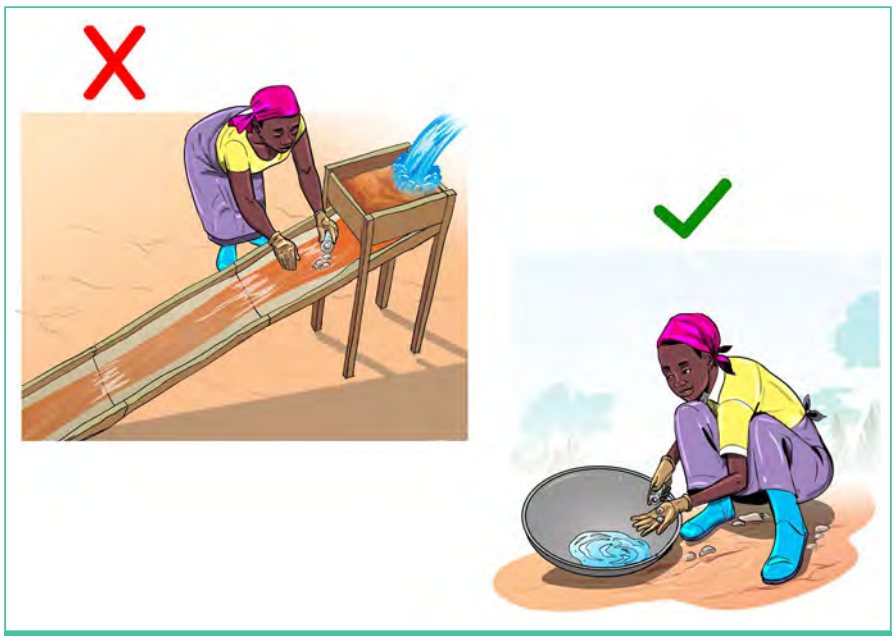

Image 5 : Worst practice is whole ore amalgamation. Add mercury only to concentrates.

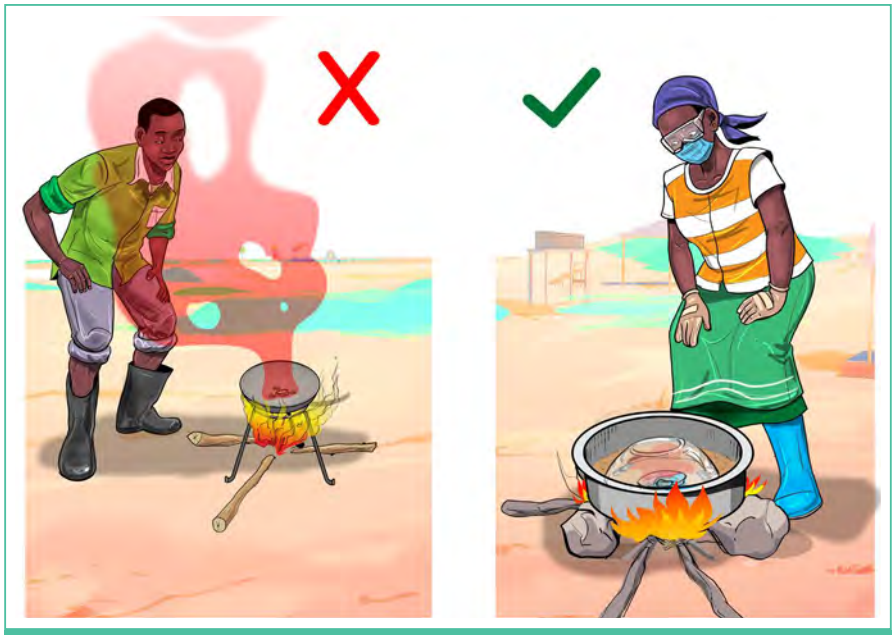

Image 6 : Worst practice is open burning of amalgam. Use a retort.

Image 7-A : Worst practice is burning amalgam in residential areas.

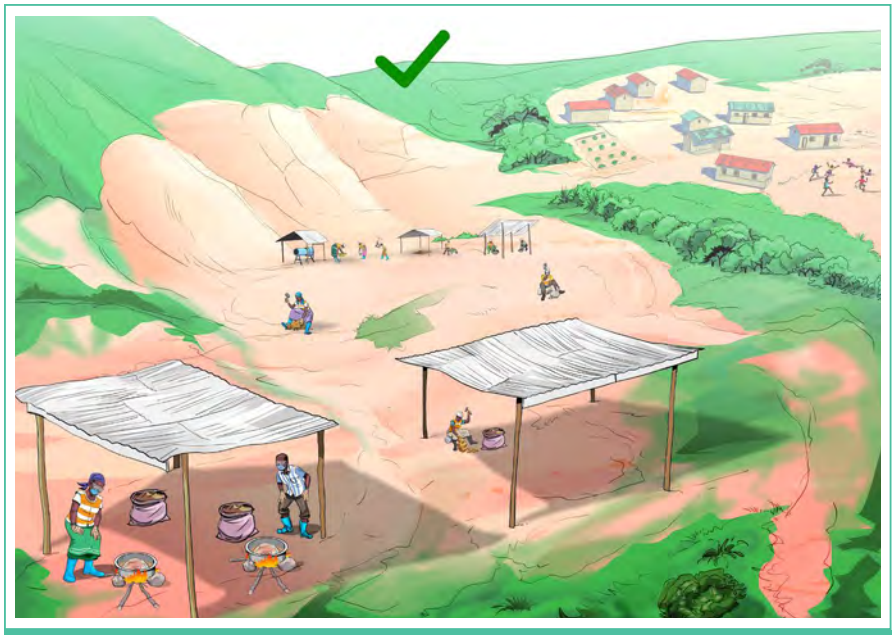

Image 7-B : Process mercury in designated work areas.

Image 8-A : Worst practice is to dispose of mercury into local water sources.

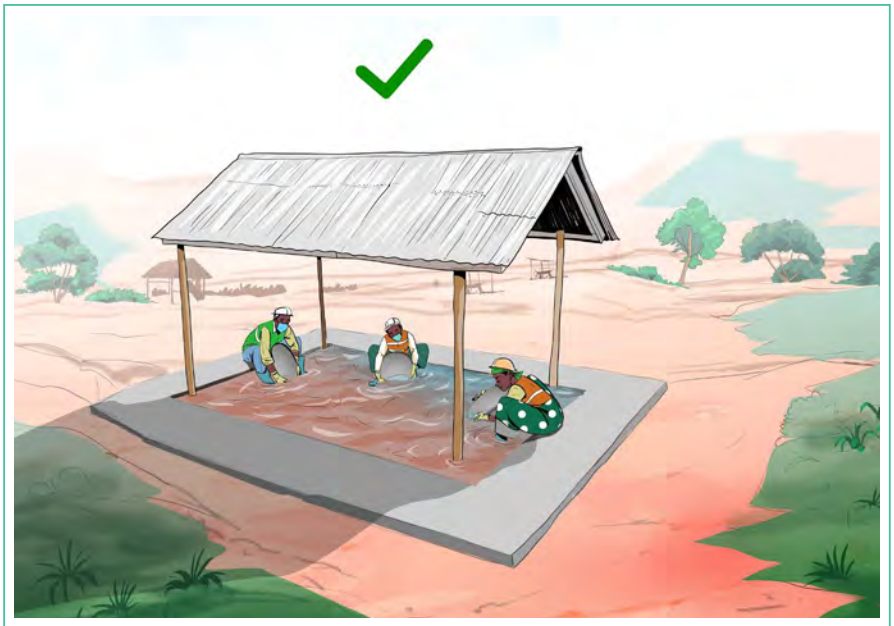

Image 8-B : Use designated amalgamation pond.

The goal with mercury elimination is to:

- Increase or maintain miner income.
- Stop danger to human health and environmental contamination.
- Introduce different types of technologies based on the different ore types to be effective.

Improving health and safety can improve incomes for miners as they will not face as many illness, injuries, or health costs. Improved processing techniques can also lead to increased incomes.

ACTIVITY

As a group, discuss the following questions:

1. How is mercury currently being used at your mine site during processing?

2. Is there an opportunity to reduce its use?

3. Is there an interest to eliminate the use of mercury? Why or why not?

4. What are the barriers to eliminating mercury?

Choosing the Right Equipment

Mercury elimination is achieved by using mercury-free technology. There are different types of mercury-free technology and the most appropriate equipment should be selected.

The following factors contribute to the selection:

- **Sizing:** The size of gold particles in the ore.
- **Mineralogy of the ore:** Whether it is free gold or associated with other minerals. If gold is associated with other minerals, processing is difficult, and gravity concentration is less effective.
- **Gold grade:** The higher the grade, the better the concentration by gravity. Low-grade ores make gravity concentration such as sluicing labour intensive for the small amounts to be recovered.
- **Size of production:** Equipment capacity affects the production size they effectively work with. Sluice sizes must align with production to be processed. A pan is suitable for small amounts of materials. Equipment such as centrifuges and shaking tables are suitable for larger amounts of ores for processing.
- **Cost:** The price and accessibility of equipment affects the miner's capacity to purchase, operate and maintain it. The cheapest equipment are pans and sluices.

Different technologies can be combined within a circuit to achieve better gold recovery.

Basic Mercury Elimination Techniques Available

There are several basic techniques available to eliminate mercury. Sluices are effective for coarse gold or large particles of gold (larger than 40um size), while centrifugal concentrators and shaking tables are effective for recovery of fine or small particles of gold (less than 40um size).

Other more advanced techniques available for mercury-free gold processing (outside of the scope of this module) include jigs, spirals, centrifuges, shaking tables, chemical leaching, flotation, and use of other chemicals.

These technologies are used in different combinations to achieve high gold recovery.

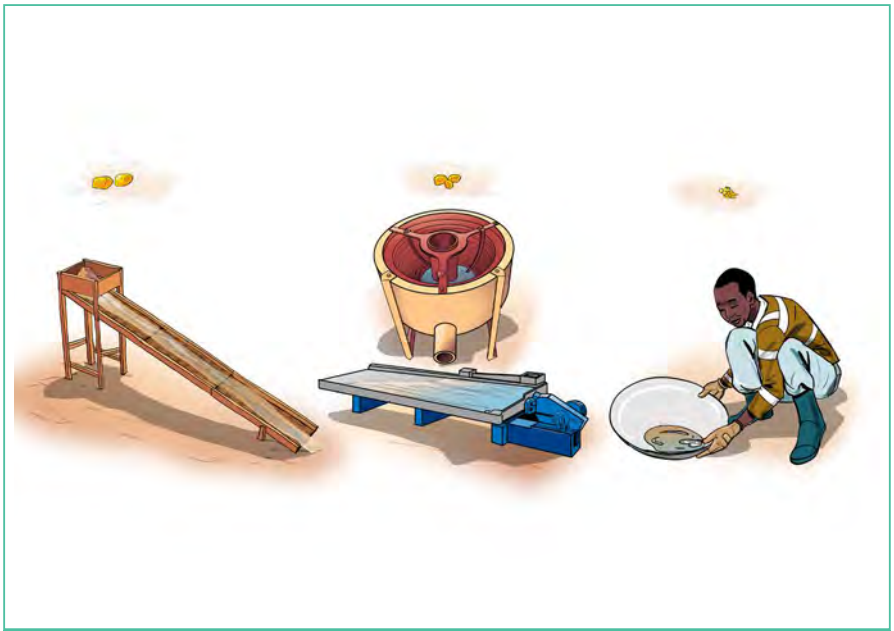

Image 9 : Use technologies in different combinations to achieve high gold recovery.

ACTIVITY

As a group, discuss the following questions:

1. What are the factors you would need to consider when selecting mercury-free equipment?

2. Which equipment have you interacted with and which ones did you find effective?

Basic Mercury-Free Techniques

NOTE TO THE FACILITATOR

This training should include a demonstration of best practices and hands on learning. The trainer can include a demonstration of dry processing techniques, panning, and an upgraded sluice.

Dry Processing

Dry processing is a method used in gold mining to recover gold from its ores without the use of water. It is commonly used in areas with little or no water, or in remote areas where the delivery of water is difficult and expensive. The ore should be dry, otherwise dampness affects the effectiveness in processing.

The most basic form of dry processing is use of winnowing: using a dish with shallow depth and wind blowing off the sand or gangue material (which is a non mineralized material that is lighter than the heavy mineralised material). The coarse gold remains at the bottom of the dish. This can be used in desert areas where there are a lot of strong winds.

A mechanized version of dry processing is a dry washer which uses a small sluice (30cm long) that has an air blower beneath it releasing a stream of high-speed air that blows off the light ore material and leaves the heavy gold on the sluice base. The remaining concentrate is collected onto a pan and further cleaned, either by blowing from the mouth or using minimal water. The air blows into a perforated sluice base that allows air to blow off the light materials off the sluice, leaving the heavy material and the gold on the surface of the sluice. The concentrate is poured into a pan and further cleaned. In the case of nuggets and course gold, these are selected and packaged without the use of mercury. In case of smaller gold particles, the concentrate can be further treated to reduce the waste material and the gold packaged for further cleaning during smelting.

Image 10 : Dry processing.

Panning

Panning is a traditional, simple, and widely used concentration method for recovering gold from ore without the use of mercury. Panning is also good in gold prospecting because of the quick and simple gold recovery process. While panning can be used in gold amalgamation, continous removal of gangue material through panning results in a clean, mercury-free gold concentrate.

In the past, wooden gold pans were considered to be the best type of gold pans because of their rough surface. However, today other options exist that have enhanced designs with grooves and riffles to enhance gold trappings. These pans comes in metal, wooden and plastic designs. They have different properties to achieve improved efficiency in gold recovery.

ENHANCED PANS

- Made of different materials including plastic and metal
- Made in a variety of shapes
- Resistant to corrosion and wear, lightweight, and easy to carry
- Have raised edges to help trap gold particles
- They have bright colors and gold can easily be spotted
- Have textured edges for better grip
- Minimal maintenance and easy-to-clean
- Enhanced designs enable increased gold trapping and recovery

HOW TO USE AN ENHANCED PAN

1. A small amount of concentrate is put into a pan
2. Water is introduced into the pan to wet the concentrate or a pan is put under water, gently shaking
3. A hand is used to mix the water with the concentrate, releasing gold particles, and at the same time, the hand is used to remove larger particles
4. The pan is slightly tilted and the mixture is swilled, which causes the light materials to be flushed over the edge and heavier material (including gold) settling at the bottom
5. More water is added until all the light materials are flushed out and gold is left in the pan
6. Any metallic susbtances with the gold particles are removed by use of magnet, leaving cleaner gold particles
7. Gold is carefully removed from the pan

Advantages:

- Low cost
- Final product does not require amalgamation
- No need for further processing and it reduces the need for mercury
- Pans are readily available and plastic kitchen dishes are an option
- Portable
- Easy and quick way to demonstrate mercury-free technology

Considerations:

- Panning requires practice for proficiency
- It is used after sluicing to enrich the gold concentrate
- Useful for small volumes of material
- Good with coarse gold as finer gold like gold dust floats away to the tailings
- A fine water spray can be used to break the flow, so the fine gold gets deposited to the bottom of the pan

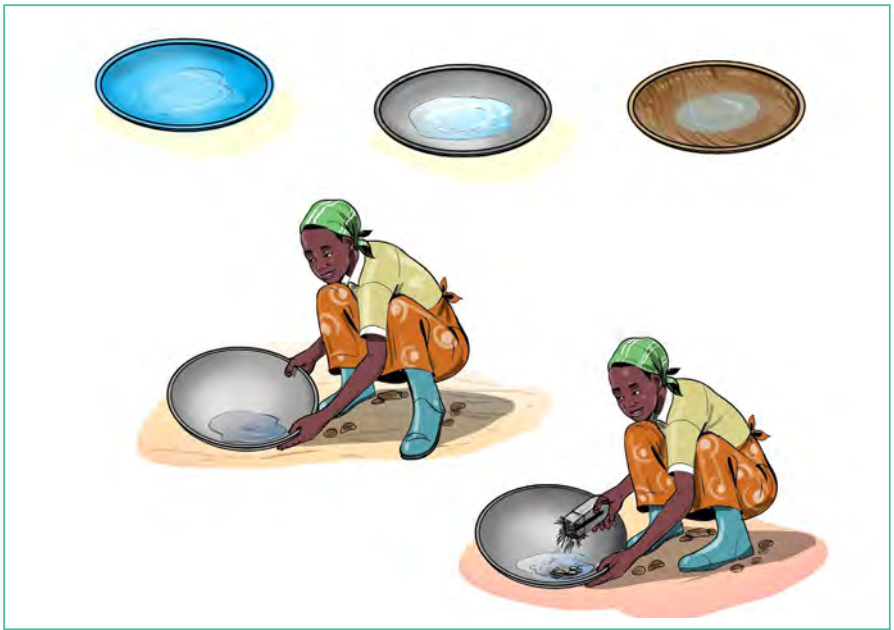

Image 11 : Panning.

Using Sluices for Mercury Elimination

A small sluice (30-50cm length) in a straight or zig-zag design is used to upgrade or further clean gold concentrates recovered from the primary or main sluice. The primary sluice can produce between 5-10% of gold in concentrate and the upgrading sluice should increase concentration to more than 90% of gold in the concentrate to enable direct smelting.

The upgrading sluice increases concentration through the further removal of gangue material and eliminates the need for mercury use. The resulting clean concentrate can be further treated through direct smelting or sold to the market in granular form.

Good matting is used to make the concentrate upgrade efficient. Matting used depends on the particle size of gold being recovered. Finer gold requires woollen mats, and coarse gold requires riffled and nomad mats. It is also an advantage to use mats that are easy to clean such as rubber mats compared to woollen mats, as these reduce the time taken for cleaning the gold concentrate. Learn more about different sluice mats in *Module 8: Basic Mining Techniques to Improve Efficiency and Safety.*

HOW TO USE THE CONCENTRATE UPGRADE SLUICE

1. For a good water and concentrate flow, the concentrate upgrade sluice must be securely positioned to handle water at a 5 to 15-degree angle.
2. Slowly feed the main sluice concentrate onto the small concentrate upgrade sluice so that the matting effectively captures the gold.
3. The pressure of the water flow must be able to wash away light materials and allow gold to settle and be captured by the matting. Too much water speed washes away gold while a slow speed results in blockages.
4. The operator must always be present to check for the accumulation of gold.
5. From time to time, the flow of water must be stopped, the matting removed carefully, washed in a container for trapped gold, matting replaced and feeding resumes.
6. The clean concentrate can be rewashed to further remove any gangue material and increase cleanness for direct smelting or direct sale to the market.
7. After adequate cleaning runs, a clean concentrate is achieved without using mercury. Some fine gold could be lost to the tailings due to the degree of concentrate cleaning required. The tailings from this process can be re-sluiced with the next ore or sold to buyers to compensate for any gold lost during the concentrate upgrading process.

Advantages:

- Very low cost
- Local production
- No motor or moving parts
- Easy operation
- Good recovery, even for fine gold if properly operated
- Can be used by individuals or groups

Considerations:

- Requires a lot of repetitive cleaning to generate a clean concentrate for direct smelting
- Chances of losing very fine gold to the tailings

Image 12-A : Upgraded sluice.

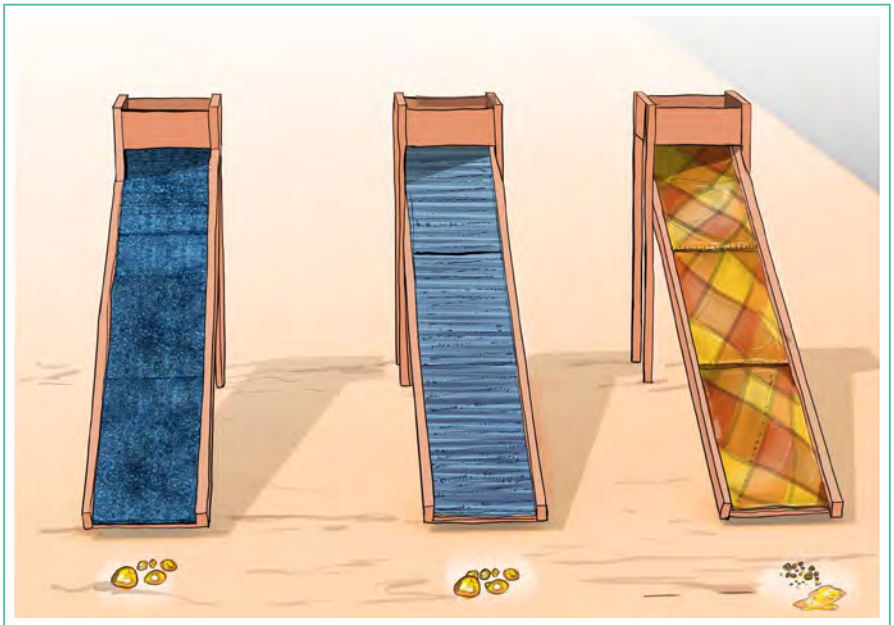

Image 12-B : Matting used depends on the particle size of gold being recovered.

ACTIVITY

As a group, discuss the following questions:

1. Do you already use any of these processing techniques at your mine site?

2. Do you think of them as mercury-free processing techniques? Why or why not?

3. How can some of these mercury-free processing techniques be introduced and more widely used across your mine site?

Additional Mercury-Free Processing Techniques and Tools

NOTE TO THE FACILITATOR

This training should include a demonstration of best practices and hands on learning. The trainer can include a demonstration of the Gold Cube, Vortex Concentrator, and direct smelting.

Gold Cube

The Gold Cube is an improved version of a concentrate upgrade sluice. The concentrate upgrade sluice can be made in various sizes and with different types of mats for effective gold capture. 2 to 5 sluices are arranged in a zig-zag sequence with high performance mats on them. The size of each sluice is 30-40cm long and 20-30cm wide. Gold concentrates from a bigger sluice or primary sluice are fed over the gold cube. The gold gets trapped on the mats and the lighter material is washed as waste.

This process removes the waste and leaves the concentrate cleaner, eliminating the need to add mercury to recover the gold. The resulting concentrate has over 80% gold content. The concentrate can be further cleaned through panning to produce a product that can be smelted directly or sold without need for amalgamation.

The Gold Cube is effective for upgrading both coarse and fine gold particles. Water recycling is done with discharge water returned to the sluice. A pump is used for recycling, or this can be done manually for smaller sizes of concentrates. This enables miners to conserve water and reduces pollution to the environment.

Considerations:

- Generally low cost and high efficiency
- Portable
- Easy to use
- Good for individuals or small groups
- Can be locally fabricated
- Needs a power source if recycling process water using a water pump
- Basic equipment for mercury free gold recovery

Image 13 : Gold Cube.

Vortex Concentrator / Blue Bowl

The vortex concentrator, also known as a blue bowl concentrator, is like a mechanized pan dish. It produces high-quality concentrate especially for fine gold. A vortex concentrator can be purchased from equipment dealers. It is gaining popularity as an alternative equipment for mercury-free gold processing.

It uses a rotating water flow to successfully gather valuable materials, with heavy items at the bottom and light material floating. The miner turns off the water and prepares to extract the gold after seeing only gold remaining at the bottom of the bowl. This can be used by individual miners and allows processing larger quantities than a manual pan dish. It works with a 12V battery, like the one used in cars to power their mechanical operations.

HOW IT WORKS

1. Must be placed on a stable surface for effective separation and connected to a water source such as a garden horse or water pump.
2. Water is introduced through a hole at the base of the bowl, making sure that it produces a gentle swilling action inside the rotating bowl.
3. The concentrated material is slowly introduced into the centre of the bowl.
4. Due to gravity and the resultant centrifugal force caused by the rotating electric-powered pan, lighter materials are pushed out while heavier gold particles sink to the bottom.
5. From time to time, the bowl is stopped, and the gold is collected from the centre of the bowl.

Advantages:

- Completely mercury-free.
- Very good at capturing fine gold.
- Basic and low-cost equipment.
- Easy to use, with little technical skills needed.

Considerations:

- The water flow rate must be carefully managed to prevent the loss of gold particles through the drain.
- Make sure that the tub, water input, and drain are operating correctly. Regular maintenance is needed.
- You need power and maintenance support locally.

Operating tips:

- Use clean water for best results.
- Keep a careful eye on the water flow and adjust it as needed to increase the concentration of gold.
- To keep the machine operating effectively, always clean the bowl and get rid of any material buildup.

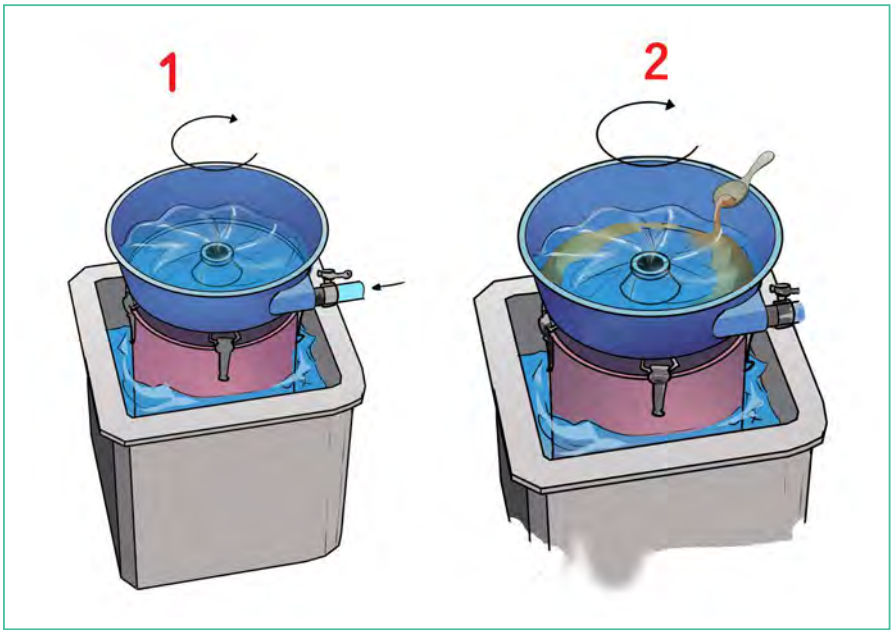

Image 14-A : Vortex Concentrator.

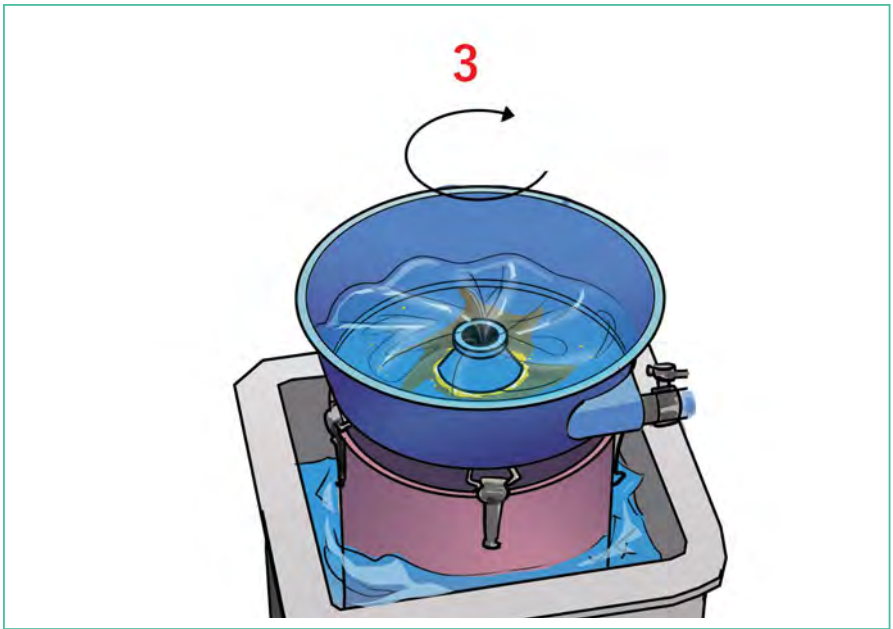

Image 14-B : Vortex Concentrator.

Direct Smelting

Miners use sluices or other gravity concentration techniques to produce a gold concentrate. When the concentrate is cleaned to remove substantial heavy sands, it can be smelted directly to produce gold doré. Direct smelting can be done effectively when gold in the concentrate by volume is more than 90%. It's therefore important to have a high degree of concentration before direct smelting.

Effectivenes of direct smelting is influenced by the quality of concentrate produced from the gravity processing. Good processing will produce a clean concentrate compatible with smelting. If the concentrate has lots of black sand, the smelt fails to generate homogenous liquid metal and the resultant gold doré is disseminated and mixed with sandy material.

To generate a cleaner concentrate it is inevtiable that smaller amounts of gold will be lost during processing, compromising the amount of gold recoverable by mercury-free gold recovery methods. Direct smelting is not effective with low grade ores as a lot of material is required to generate a sizeable concentrate.

HOW IT WORKS

Using charcoal and a blower:

1. The gold concentrate is mixed with borax as a flux and put in a closed flammable container, making sure that it is not too full. The container is to protect the concentrate from being blown off during the initial phases of blowing. The recommended ratio is 1 part gold concentrate and 3 parts borax.
2. The container with concentrate is put inside a small ceramic bowl filled with charcoal.
3. The charcoal is lit and a hand-powered blower is used to intensify the burning of charcoal.
4. Depending on the intensity of the heat, the metals and minerals in the concentrate begin to smelt and small drops of gold stick together at the bottom of the bowl. Heat should continue being applied on the crucible to increase smelt and gold purification.
5. Once smelting is complete, the slag is tipped off the crucible leaving the gold at the bottom. The gold is allowed to cool and removed using a tip of a knife or metaling tongs depending on the size of the smelted gold.

Borax is used a flux to aid in removing the other mineral impurities by lowering their melting point. This makes separating the gold during smelting a much simpler process. The flux is mixed with the gold concentrate and smelted together.

Considerations:

- Only small batches of gold concentrate should be smelted at a time.
- Proper safety equipment, like heat-resistant gloves, a mask covering mouth and nose and eye protection, must be used when handling the hot crucible and molten gold.
- The smelting area should be well-ventilated to prevent breathing in any fumes.
- The smelting waste needs to be carefully collected and disposed of in compliance with environmental requirements and local regulations.
- The time taken during direct smelting depends on the amount of concentrate being smelted.
- The process takes longer to complete.
- The requirements for a clean concentrate for direct smelting leads to loss of some gold during concentration.

Advantages:

- Produces a highly pure gold product without the use of mercury.
- The process is easy to follow and can be done by artisanal and small scale actors.
- Improves the quality of the concentrate, which helps to increase the value of your gold recovery efforts.
- For smaller-scale operations, the concentrate can be upgraded by panning before smelting.

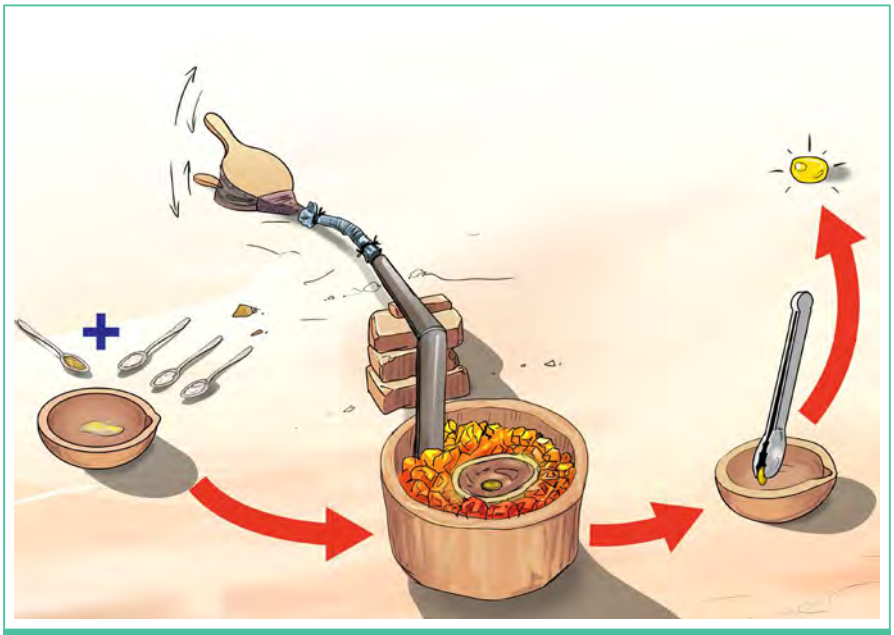

Image 15 : Direct smelting.

ACTIVITY

As a group, discuss the following questions:

1. Do you already use any of these processing techniques at your mine site?
2. What are the main advantages of each type of mercury-free processing technique?
3. What makes these techniques attractive for mining operations?
4. Which ones would be the most appropriate for your mine site? Why?
5. How can you introduce some of these mercury-free techniques to your mine site?
6. How can you increase awareness among miners on reducing and eliminating mercury use?

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The **planetGOLD Uganda** project aims to reduce the use of mercury by supporting formalization of the artisanal gold mining sector and increasing access to finance. This will lead to adoption of mercury-free technologies and allow access to more responsible and traceable gold supply chains. The project is supported by the Global Environment Facility, led by the UN Environment Programme, executed by IMPACT in partnership with Uganda's National Environment Management Authority and the country's Ministry of Energy and Mineral Development under the Department of Mines.
www.planetgold.org/uganda

The **planetGOLD Côte d'Ivoire** project aims to reduce the use of mercury in the artisanal gold mining sector through a holistic, multi-sectoral and integrated formalization approach. The project also aims to improve access to traceable gold supply chains and financing for the adoption of sustainable, effective and practical mercury-free technologies. The project is supported by the Global Environment Facility, led by the UN Environment Programme, executed by the Centre Africain pour la Santé Environnementale (CASE) and IMPACT.
www.planetgold.org/cote-divoire

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MODULE 8:
BASIC MINING TECHNIQUES TO IMPROVE EFFICIENCY AND SAFETY

FACILITATOR'S GUIDE

Supporting Best Practices at Artisanal Gold Mines Toolkit

Supported by gef

Led by UN environment programme

In partnership with Canada

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Learning Outcomes

BY THE END OF THIS SESSION, PARTICIPANTS SHOULD:

- Understand the basic mining cycle
- Understand basic equipment used in artisanal gold mining
- Understand techniques to make gold mining more efficient
- Improve gold recovery with improved panning and sluicing techniques
- Promote safe practices with equipment handling

NOTE TO THE FACILITATOR

It is recommended that this training should be completed by someone who is familiar with artisanal gold mining techniques and who has had previous training on the equipment presented within this module.

While the training offers learning and discussion, it should be accompanied by demonstrations of the equipment and hands-on learning. It is recommended that the training take place near or at a mine site.

Introduction to Mining

Mining is the removal of valuable minerals from the earth. The activities of a miner include searching (exploring or prospecting) for mineral ores, removing them from the ground, processing them into a valuable mineral product, and marketing or selling the mineral product.

The Mining Cycle

Mining involves multiple steps to have a final product ready for sale.

- **Prospecting or exploration** is the search for mineable or economic mineral deposits. Prospecting techniques used in artisanal and small-scale mining (ASM) include observing the landscape for clues, identifying outcrops, previously mined areas, edges of large-scale mining companies, or digging pits and trenches to identify mineralized areas. Samples are processed and panned to see if they contain gold. Some miners use traditional knowledge passed down through generations, for example spotting the presence of certain features in the landscape which can be linked to mineralization. Certain vegetation thrives in areas with underground water due to its association with rock fractures. Based on local knowledge miners can use these features as indications for prospecting.

- **Gold mining** involves making excavations on the earth's surface to extract minerals for processing and recovery of gold. Mining can be surface mining or underground mining. Most common mining in ASM is alluvial and eluvial. This type of mining takes place on riverbanks, riverbeds, mining of outcrops, or digging pits to access gold veins underground.

- **Processing** is the extraction of valuable minerals from the rocks or mineral-rich material and selling to the market. Processing techniques include sluices with mats, pans, and simple equipment to recover gold. Miners can also use gravimetric equipment for processing, if they have the resources.

- **Tailings disposal** is when the valuable mineral has been recovered, the barren material is disposed of as tailings. Due to poor processing techniques, the tailings dump may still have gold which can be further processed.

Image 1 : Prospecting.

Image 2 : Gold mining.

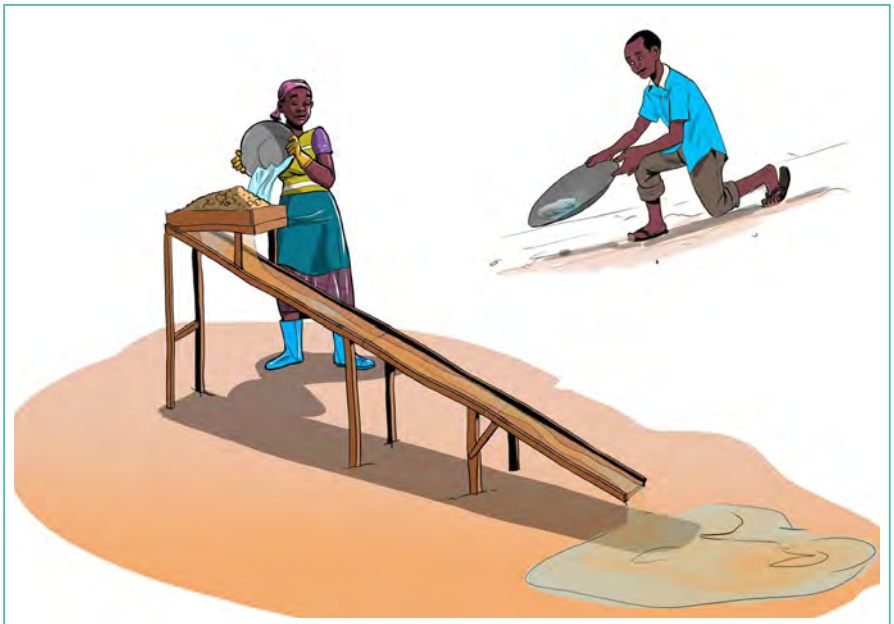

Image 3 : Processing.

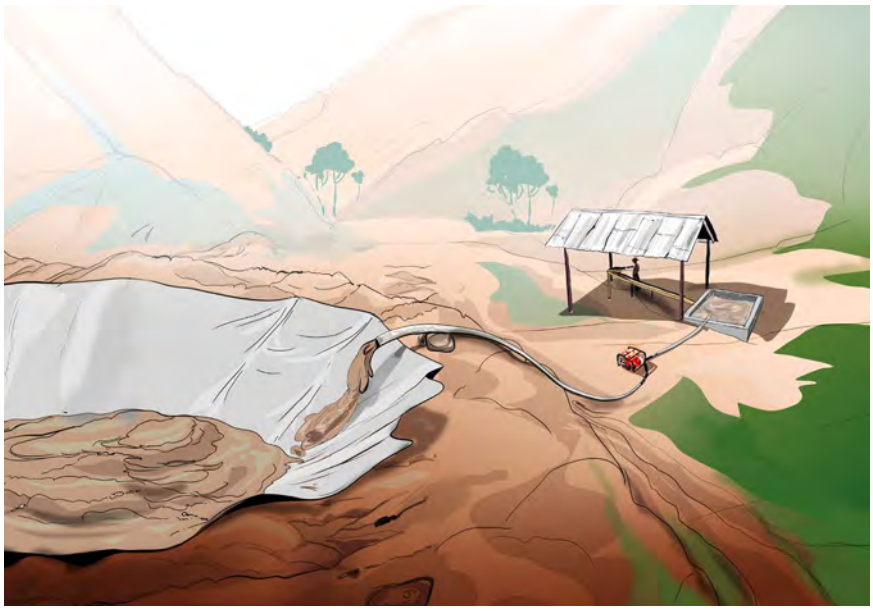

Image 4 : Tailings disposal.

NOTE TO THE FACILITATOR

Ahead of the training, the trainer should research and become informed about mercury use in the area, as well as locally available equipment for safer handling.

Surface Mining Methods

Surface mining involves making excavations that are entirely open at the surface which can form a pit, trench, or quarry. Sometimes small shafts are dug to reach the mineralized zone.

For artisanal gold miners, the most common surface mining methods are:

- **Open-Pit Mining:**
  Miners often dig pits between 2m to 10m diameter randomly following the mineral veins, leaving the land degraded. The pits are dug through the soft surface soil and loose rocks. During the rainy season, the pits get flooded and abandoned, unless miners have the capacity to pump the water.

- **Alluvial / Eluvial Mining:**
  Miners use shovels and pickaxes to dig and extract minerals from sand, gravel, or weathered rock deposits in rivers or on hillsides. Eluvial deposits are located very close to the primary vein, while alluvial deposits are located further from the primary vein. Mining of eluvial veins often leads miners to the main deposit.

- **Tailings Recovery:**
  Old tailings are re-processed to extract minerals that were not recovered during previous processing.

Image 5 : Open-pit mining.

Image 6 : Alluvial mining.

Image 7 : Tailings recovery.

SURFACE MINING HAS THE FOLLOWING ADVANTAGES

1. It can be used for mining small mineral deposits lying close to the surface.
2. The method is relatively safe, because nearly all the mining operations are conducted in an open atmosphere and not an enclosed environment. However, to prevent accidents, it still needs to be done correctly without leaving steep walls or undercutting.
3. It has better lighting and conditions for labor.
4. It can be easier to introduce mining equipment.

Image 8 : To prevent accidents mining needs to be done correctly without leaving steep walls or undercutting.

ACTIVITY

As a group, discuss the following questions:

1. What are the main activities in a mining cycle? What part of the cycle do you participate in?

2. Which type of mining is common in your area?

3. Do women participate equally in mining? What challenges do women face and what are the possible ways to improve their participation across the mining cycle?

Common Equipment Used in Artisanal Mining Operations

ASM is usually carried out using manual mining methods. However, miners can be supported throughout the mining cycle with various equipment.

Equipment for Breaking Ground or Rock

- Picks and shovels
- Hammers and chisels
- Hand-operated rock drills
- Diesel, electric-powered rock drills
- Pneumatic rock drills
- Pumps and high-pressure water guns or water jets

USE AND MAINTENANCE OF CHISELS AND HAMMERS

1. Use a chisel that has been properly sharpened. Do not use a dull chisel.
2. Do not use chisels or hammers with damaged, mushroomed, or rounded heads.
3. If possible, hold the chisel using a tool holder.
4. Regularly sharpen and maintain chisels, as well as smoothen hammers to prevent injuries.
5. Ensure the hammers are in good condition.

USE AND MAINTENANCE OF DRILLING EQUIPMENT

1. Ensure the equipment is clean before use.
2. Prevent dust and dirt from entering the equipment and clean after use.
3. Lubricate equipment regularly.
4. Ensure the drill heads are in good condition.
5. Be gentle when using the equipment and when storing it. Don't throw the equipment from one point to another.
6. Regularly service the equipment.

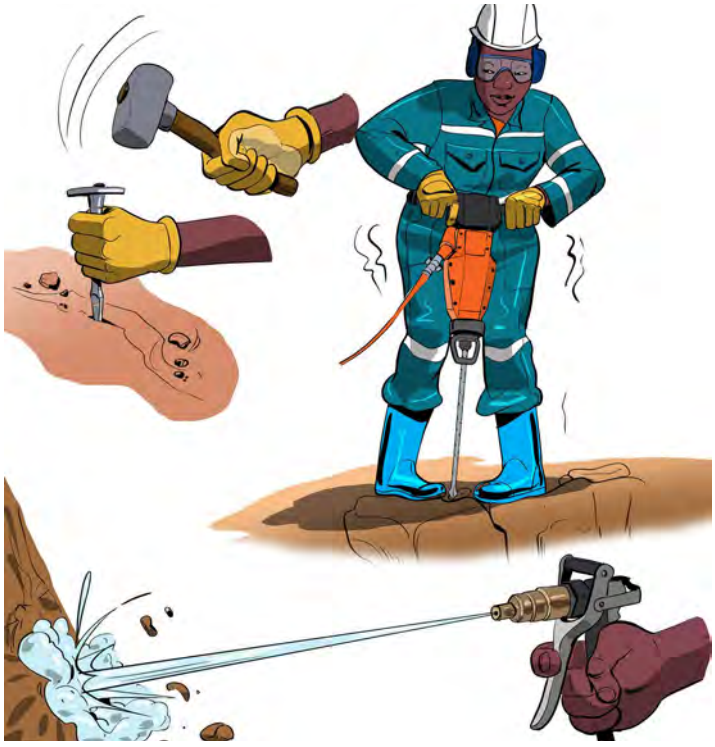

Image 9 : Equipment for breaking ground or rock.

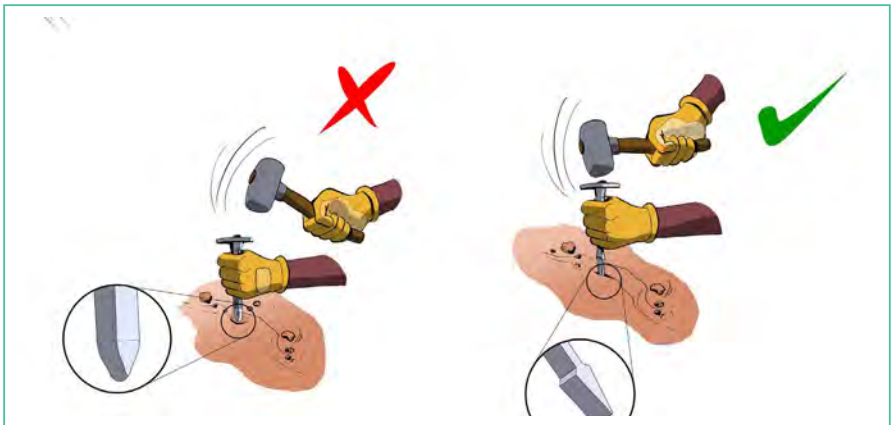

Image 10 : Use a chisel that has been properly sharpened.

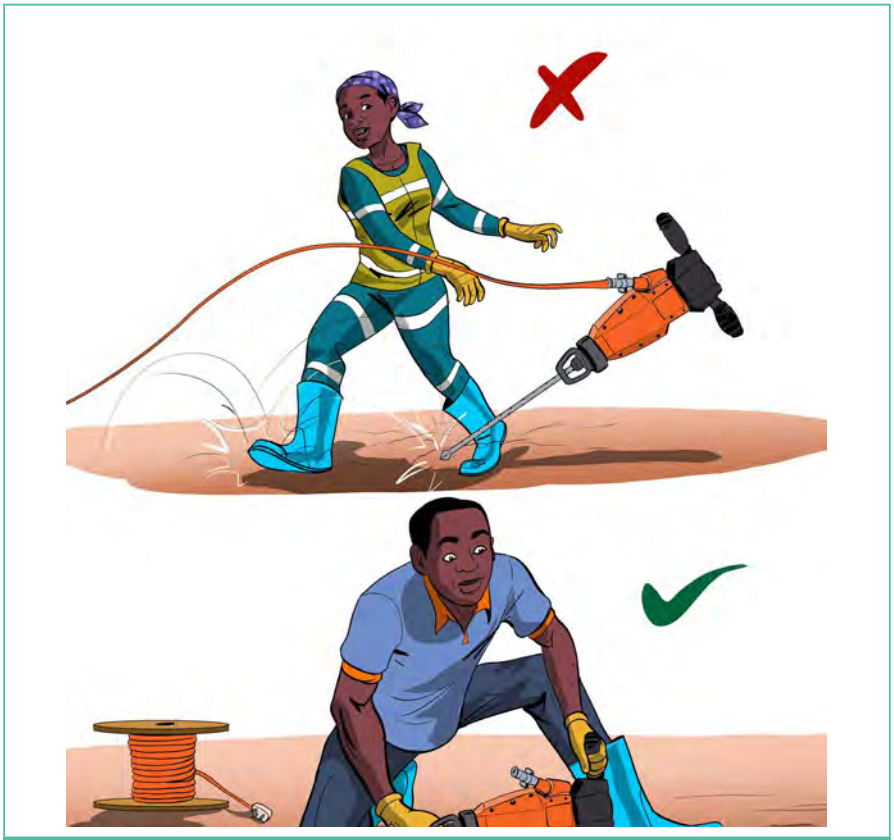

Image 11 : Don't throw the equipment from one point to another.

Equipment for Loading and Hauling

- Shovels, spades, and hoes
- Wheelbarrows
- Carts and trolleys
- Hand operated winches

USE AND MAINTENANCE OF EQUIPMENT FOR LOADING AND HAULING

1. Clean off mud and water from shovels. Wipe with an oily rag after use to prevent rusting.
2. Clean the wheelbarrow handles and pans, wipe them dry, and scrub with a wire brush to remove stains and residual mud. Wet mud can destroy the pan over time.
3. Grease the wheelbarrow axle before it starts squeaking. Adjust frequency based on usage and perform pre-task checks.
4. Check the winch hoisting rope for breakages and replace if necessary.

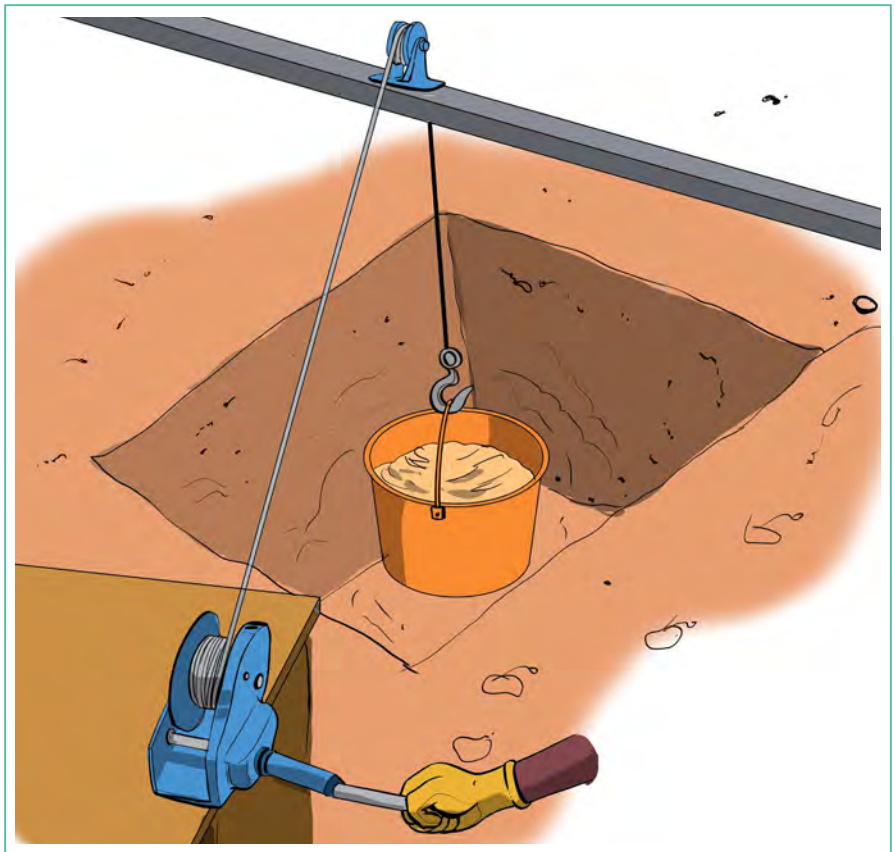

Image 12 : Equipment for loading and hauling.

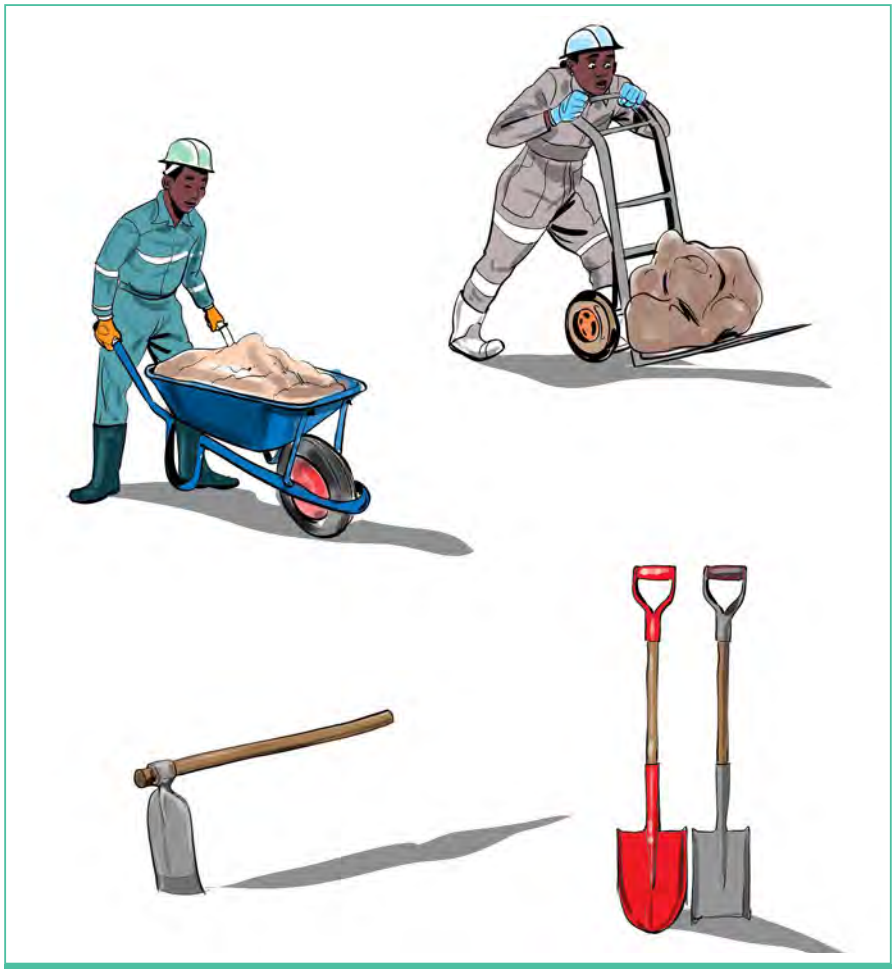

Image 13 : Equipment for loading and hauling.

Image 14 : Clean the equipment properly after use.

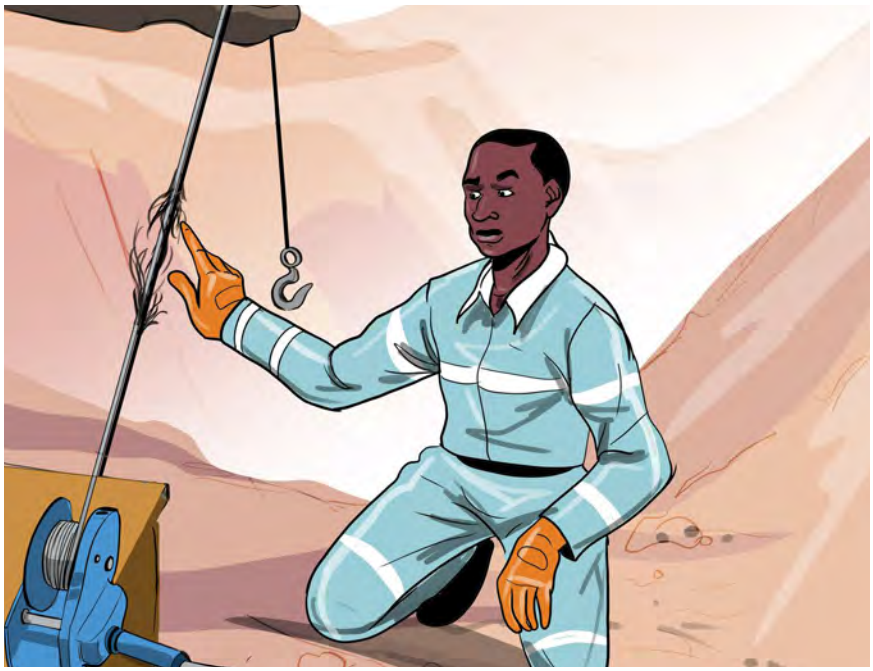

Image 15 : Check the winch hoisting rope for breakages and replace if necessary.

Equipment for Processing

- Hand crushers, mortar, and pestle
- Sieves and screens
- Pans
- Magnets
- Sluice boxes with different type of mats
- Vortex Concentrator (Blue Bowl)
- Retorts (for mercury recovery)
- Smelting equipment

USE AND MAINTENANCE OF PROCESSING EQUIPMENT

1. Use the correct equipment for the type and size of ores you need processed.
2. Pans, and a mortar and pestle should be used for small quantities, while sluice boxes work well with large quantities.
3. Check the condition of mats and equipment before use.
4. Clean the equipment after use.
5. Check that power is working before connecting the vortex concentrator.

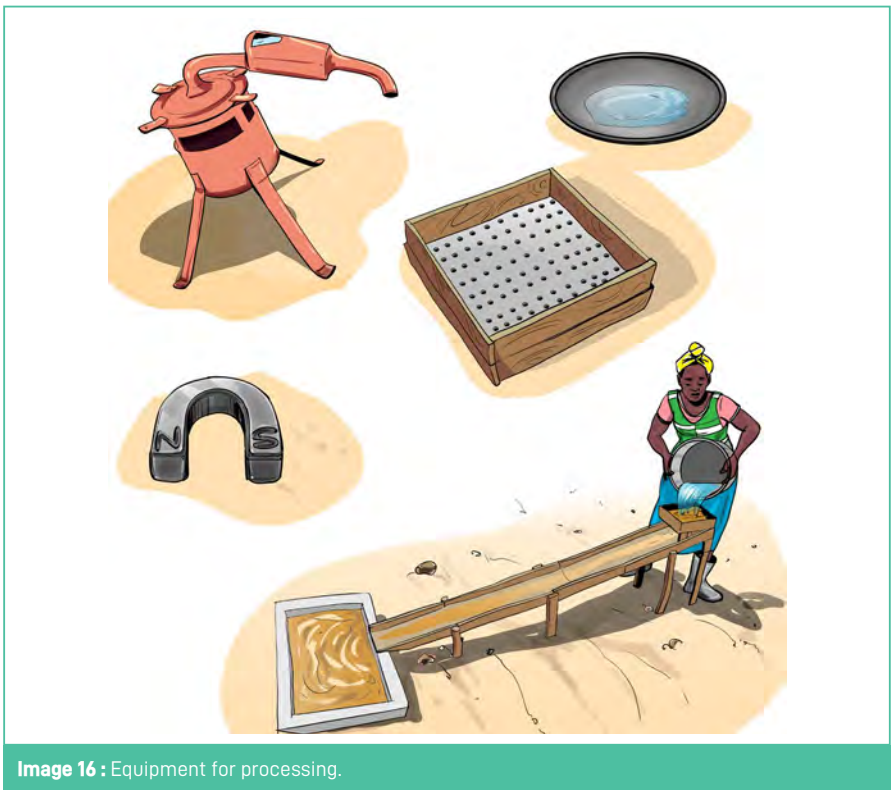

Image 16 : Equipment for processing.

Image 17 : Equipment for processing.

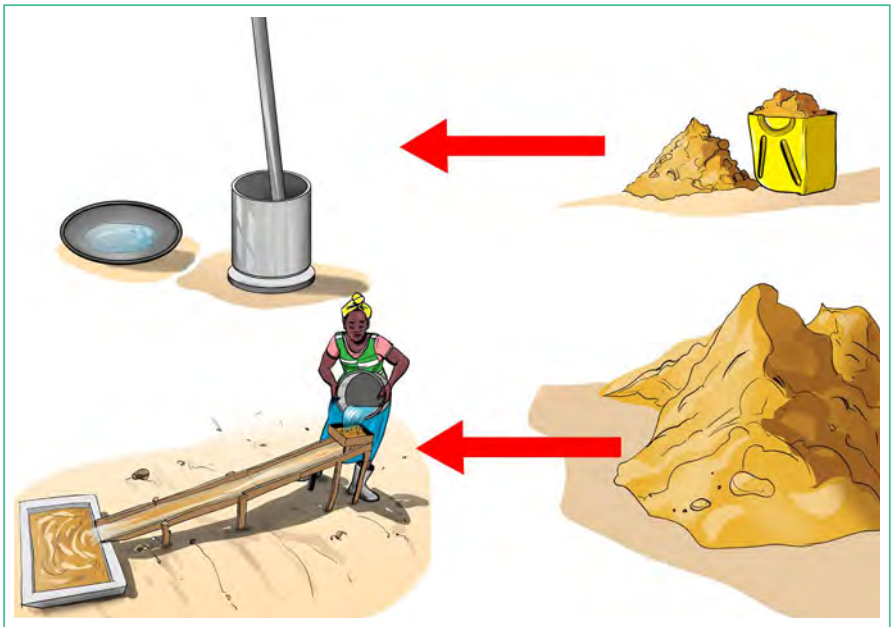

Image 18 : Use the correct equipment for the type and size of ores you need processed.

Other Equipment

- Generators (for powering equipment)
- Motor pumps

USE AND MAINTENANCE OF OTHER EQUIPMENT

1. Make sure the equipment is suitable for the task. Do not use a motor pump meant for clean water to pump slimy water. Use a motor pump suitable for slimy water for mining work.
2. Lubricate the equipment regularly using locally available grease or oils appropriate for mechanical equipment. Use news oil when possible or used oil if no other options are available.
3. Do not use a motor pump inside shafts. The carbon fumes are dangerous and can kill.

Image 19 : Motor pump.

ACTIVITY

As a group, discuss the following questions:

1. What type of equipment is common within your mine site? What equipment do you use?

2. Do women have access to this equipment? How can their access be improved?

3. How do you take care of your equipment?

4. How can equipment maintenance at your mine site be improved?

5. What are the common problems you face with motor pumps? Are people at the mine site trained to repair issues with the motor pumps? Are any women trained to fill this role?

Mineral Processing

Mineral processing is the freeing of valuable minerals from their ores. The process may involve several individual operations, such as crushing and grinding, screening, gravity concentration and product recovery through heating or refining. The remaining material is discarded as water or tailings.

THE STAGES OF PROCESSING

1. **Size reduction:** This step involves breaking down the ore to liberate the grains of the valuable mineral (or "pay mineral") from the surrounding waste mineral.
2. **Screening:** This separates the small material to undergo processing from the larger particles which need further size reduction or to be thrown out as waste. In alluvial mining, screens are used to separate larger rocks from the soils that contain gold.
3. **Sorting of minerals:** After size reduction, the particles of the valuable minerals are physically separated from the waste minerals. This produces an enriched portion or concentrate containing most of the valuable minerals, and a discard or tailings containing predominantly the waste minerals.

Image 20 : Size reduction.

Image 21 : Sorting of minerals.

Mineral Processing Techniques

Gold processing techniques are mainly determined by geological conditions, size of the mineral, and the type of environment where mining occurs (whether wet or dry). In typical ASM operations, the main equipment used for processing is the pan dish and simple sluice with matting. These are cheap, locally available, and easy to operate.

Image 22 : Sorting of minerals and panning.

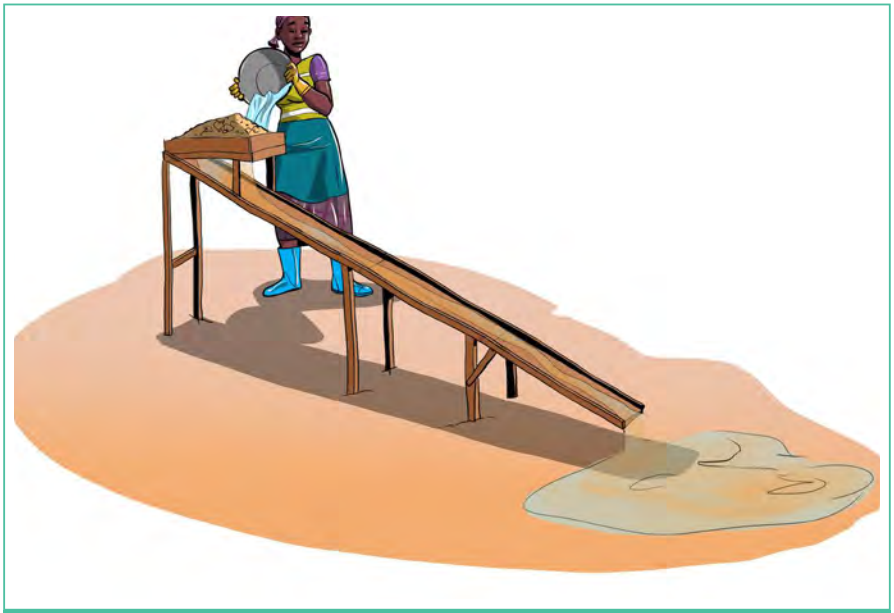

Image 23 : Sluicing.

PARTICLE SIZE

- Large particle sizes of gold can easily be processed by simple methods such as picking (for nuggets), panning, and a sluice with matting suitable for coarse gold such as square hole rubber mats.
- For smaller or micro small gold particles, sluices with good mats and other equipment such as concentrators are more efficient in recovering more gold.

GOLD ORE TYPE

- Gold ores can be classified as free milling or refractory. ASM processing usually focuses on free milling ores. Free milling involves use of ball mills, hammer mills, and gold recovery by gravity concentration such as sluicing and panning. Refractory gold requires use of complex and expensive techniques such as roasting and cyanide leaching.
- In free milling ores, most of the gold can be recovered by gravity concentration methods provided the particles sizes are big enough.
- In refractory ores, these are difficult to recover by gravity concentration and require additional processes and chemicals.

GRAVITY CONCENTRATION

Gravity concentration is the separation of gold from other minerals or waste materials using the difference in their heaviness of relative density. Gold is heavier than sand or quartz and will settle faster than sand.

ACTIVITY

As a group, discuss the following questions:

1. How do you determine what type of equipment to use to process your minerals?

2. How do you determine if you are being effective in your mineral processing?

3. What can you do become more effective?

Panning

Panning is a simple method for extracting gold from sediments or ore. It is one of the oldest and most well-known methods of gravity concentration. Using a pan is efficient when working with small concentrates and when the gold is coarse and well-liberated.

NOTE TO THE FACILITATOR

The training should include a demonstration of best practices and hands-on learning. The trainer can include a demonstration of pans easily available locally to miners, as well as other options.

Pans can be made of wood, plastic and metal. Using pans that are made of wood has the advantage of a rough surface that can hold the gold. The remaining magnetite or iron filings after panning can be removed with a magnet. A pan dish can be used by individual miners, women and men separately. They can be used without mercury if the ore is rich in gold, or the gold particles are coarse.

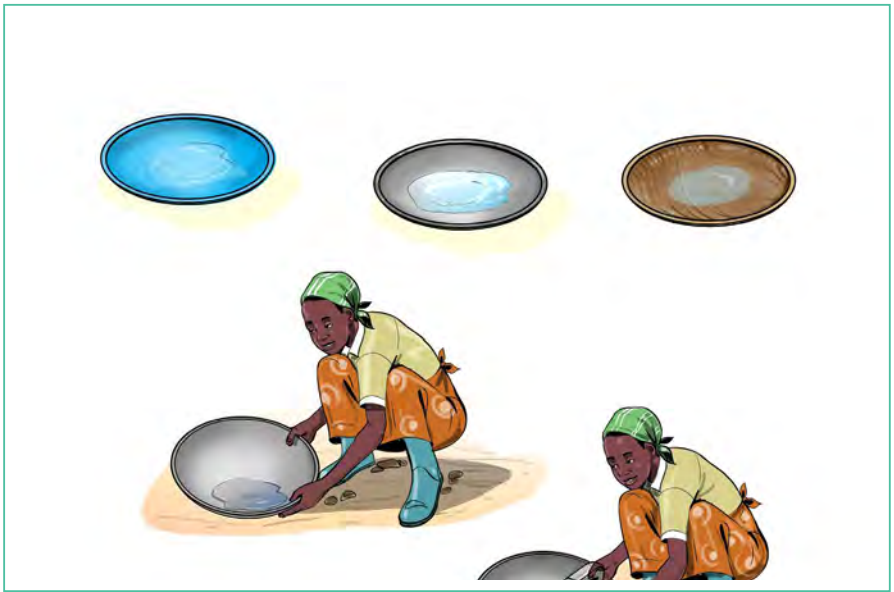

Image 24 : Panning.

ADVANTAGES OF PANNING

- Locally available, inexpensive, and easy to use.
- Provides independence for final processing, especially for women.
- Does not require a lot of water.
- Used to upgrade concentrate from the sluice.
- Reduces the need for mercury.
- The concentrate from the pan can be directly smelted if clean enough.

CONSIDERATIONS WHEN PANNING

- Successful panning requires practice to become better, faster, and capture more gold.
- It is effective in enriching sluice concentrates containing gold. It can be used after sluicing or directly for small samples which do not require sluicing.
- It works with small volumes and takes a lot of time and labour.
- It is useful when the concentrate has rich gold values and small quantities of materials to process.

ACTIVITY

As a group, discuss the following questions:

1. What type of pans are used are your mine site? Are there certain pans which are more effective?

2. Are there any challenges with panning? What are some solutions?

3. What type of gold can you pan without mercury?

4. Can panning be used at your mine site to reduce mercury? What are some strategies to promote panning as an alternative to mercury?

Sluicing

Sluicing is the process of recovering heavy minerals from alluvial materials or milled ores through gravity concentration by having the gold bearing pulp flow over an inclined channel with matting. The matting captures the heavy mineral deposited by gravity onto it, forming a concentration of heavy mineral. Well designed and operated sluices can achieve up to 70-98% gold recovery, especially for gold coarser than 0.1mm.

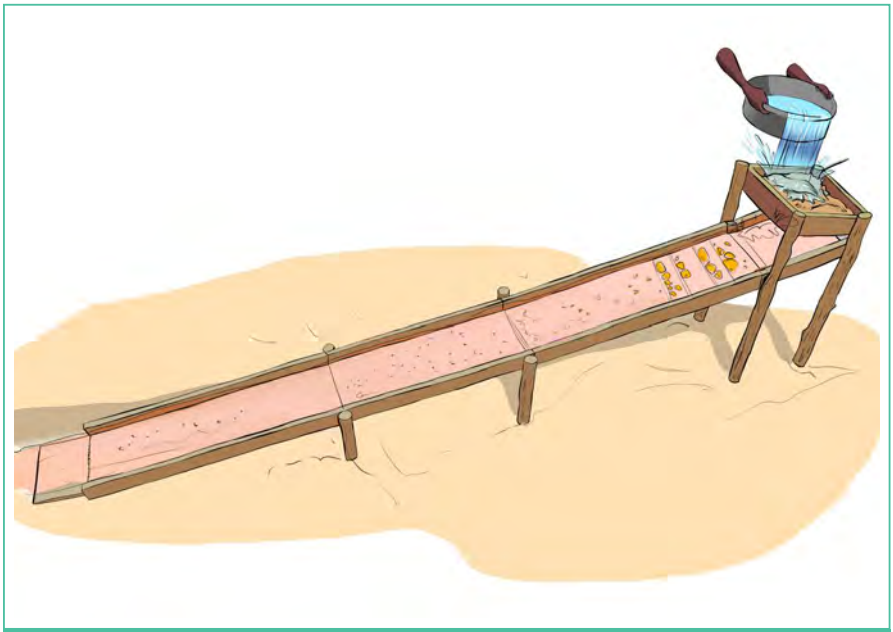

Image 25 : Sluice.

NOTE TO THE FACILITATOR

The training should include a demonstration of best practices and hands-on learning. The trainer can include a demonstration of different mats easily available locally to miners, as well as other options. The training should also include a sluice demonstration showing proper operation, different angles and water speed, as well as the application of different mats.

SLUICE BOX WITH MATTING

The sluice is the most common tool for gold recovery that the miner works with both in alluvial and primary operations due to its simplicity, low cost, popularity, and excellent recovery for coarse gold. If well operated, it can recover gold down to 0.03mm. It can recover dirty gold or gold interlocked with other minerals.

It is usually rectangular and inclined towards the discharge point. Mineral bearing material with a stream of water are fed onto the upper end of the sluice and washed down over the mat with the valuable mineral settling or concentrating on the matting.

There are different types of sluices. Some examples can include:

- Sluices are made from metal (steel, aluminum), wood, plastics, or concrete. The most rudimentary are made from clay.
- Sluices have mats laid over them for the full length. Different mats are used which include rubbers, carpets and blankets.
- Different mats can be used over the length of the sluice to trap coarse and fine gold.
- Angle riffles can be placed in the first 30cm for recovery of coarse gold. If the area has no coarse gold, there is no need to use angle riffles.

- The width and length of a sluice varies on the design selected by the user. Width can be 30cm, or 50cm while length can range from 1 to 3m. There are no standard sizes. The longer the sluice, the more surface area to deposit the gold.

It is important to make sure that material fed into the sluice is compatible with its design and size for maximum performance.

THE MAIN POINTS A MINER NEEDS TO UNDERSTAND ABOUT SLUICES ARE

- Gold settles to the bottom of the flowing stream of water due to its heavy density (19,25 g/cm^3) while the quartz or sand (2.65 g/cm^3) is carried away as tailings.
- The rate of gold settling depends on density, size, and shape of the mineral: large, dense, spherical particles settle quickly while small, light and platy particles take longer. Knowledge of gold particle size is required for effective recoveries.
- The pulp stream is layered with dense particles at the bottom and lighter particles at the top. The dense material comes into contact with the bottom of the sluice, where it is trapped and collected.
- The efficiency of mineral recovery depends on the volume of water in the pulp. The more water, the finer gold particles get washed away. The less water, the matting gets filled with waste material and recovery decreases. An optimal ratio of 4 volumes of water to 1 volume of material is recommended but also depends on the type of material being washed (i.e. clay, dry, moist).

While sluicing is very popular in ASM and has many advantages, there are disadvantages to this processing technique:

- The process is labour intensive.
- Sluicing needs a consistent supply of water. It's often done close to streams of water.
- Sluicing can contaminate local water sources, as well as harm the environment and local communities if done carelessly. Miners should recycle water, as well as cover ponds with plastic to prevent contaminating underground and surface water sources.

Screening

Screening separates the larger particles from the sand so that only the smaller particles which can flow with the water stream pass though the sluice. In general, the screen (also known as sieve) size depends on the average gold sizes common in the area and desired capacity for the operation. If the screen size is too small, it reduces the capacity of the sluice and loses some nuggets with the waste material. An average screen size of 10mm is adequate for ASM operations.

Gold processing is more efficient when the particles in the pulp are of similar size. Gold recovery by sluicing improves when finely sized pulp is processed. After screening, the sand pulp is washed over the matting and the coarser, heavier gold settles on the first 30cm of the sluice. The finer gold settles further down and the rest is discharged as tailings.

APPLICATION OF SCREENS

There are a variety of screens. The screens are placed directly over the sluice. Water is poured onto the material on the screen and the desired pulp flows over the mat.

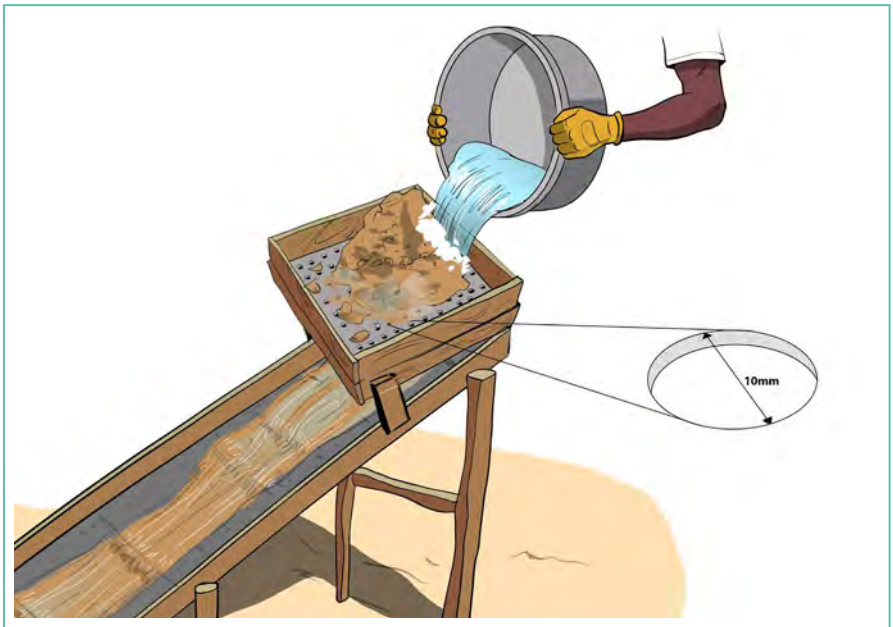

Image 26 : Sluice with screen.

Operating a Sluice

There are four main parameters that the miner needs to understand for maximum benefit from using a sluice. These are:

1. Material feed and particle size
2. Sluice design
3. Gold trapping mechanism (mats)
4. Clean up time

MATERIAL FEED AND GOLD SIZE

Coarse and granular grains settle quickly on the mats, while fine and platy gold take longer to settle. When processing fine gold, the sluice should be longer and have mats suitable to trap fine gold. A 1m sluice would not be sufficient to trap fine gold. A good sluice should be at least 3m, with a secondary sluice at the end to ensure maximum recovery.

SLUICE DESIGN

The slurry or pulp should have a smooth flow for the gold to deposit onto the mat. When the flow increases it becomes turbulent and gold gets lost in the tailings.

It's important to note:

- High speed water flow causes gold losses. Some of the finest gold particles are carried by turbulence through the sluice and into the tailings.
- Slow water flow results in clogging of the sluice hence gold loss.
- Optimum recovery is achieved when the flow rate is just fast enough to keep the mats exposed and not sanded out.

Sluice Matting

The type of matting is determined by the gold type. Some matting is good for coarse gold while others improve recovery of fine gold.

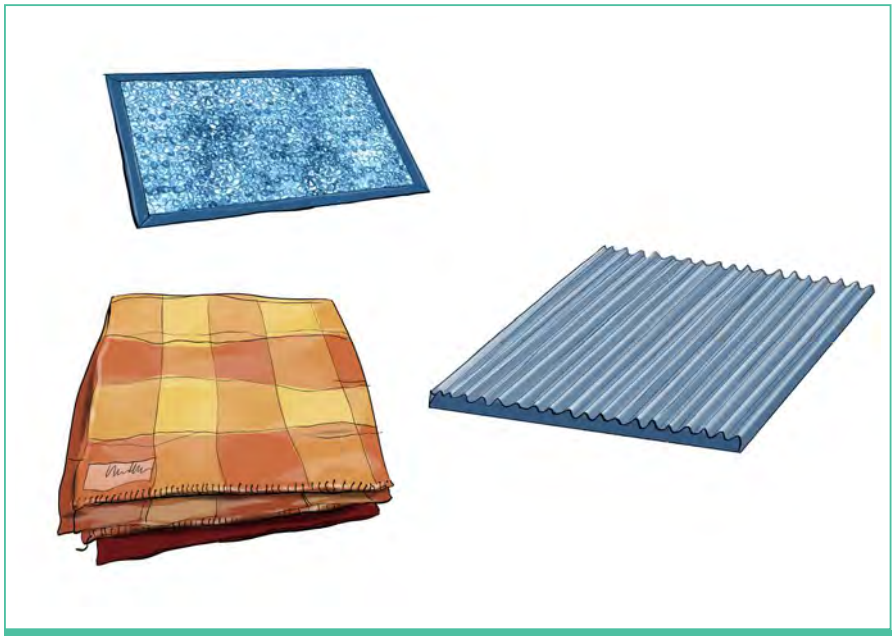

Image 27 : Different sluice mats: vinyl fiber, corduroy blanket, and corrugated rubber mat.

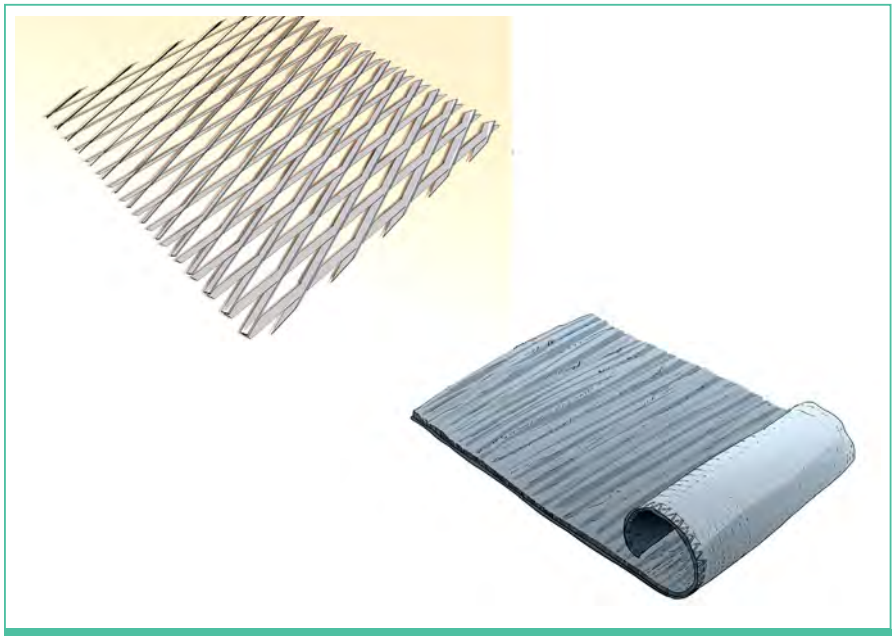

Image 28 : Metallic riffles and riffled woolen mats.

CORDUROY BLANKETS

- These are commonly used in ASM operations due to ease of availability.
- The fibrous material forms the riffles.
- They are very good for coarse gold.
- If material becomes slurry, it needs constant washing as the blanket may clog and results in great loss of gold.
- Similar materials include thick towels, corduroy material, sacking, hides.

Clean Up:

- Note when the mat is covered with slurry.
- Use a pan to check for gold in slurry discharged from the sluice. When gold shows in the pan, then cleaning should be done immediately.
- Use a large enough bucket of water that can fit the blanket used.
- Wash the blankets to remove the slurry from the mat into the bucket.
- Shake the blanket to have the gold particles on the blanket drop to the bucket.
- Clean the base of the sluice in case some gold is dropped from the blanket to the sluice base.
- Once the blanket is cleaned, return and lay on the sluice and continue operation.

Best Practice:

- Ensure there is sufficient water in pulp and not too much sand accumulates on the mat.
- Ensure the speed is sufficient to carry the light sand to the tailings.
- Do a periodic hand pan at the discharge end to check that fine gold is not getting lost. If any adjust slope, water speed and feed.
- When the mat has been covered by sand, it is time to clean up.

VINYL FIBER MATTING

- The vinyl fiber mats should have a thickness of 0.5in.
- Traps the gold inside the vinyl fibers.
- Used mainly in the front section of the sluice, leaving the rest of the sluice for other types of mats.
- Very good for both coarse and fine gold, even catching small nuggets up to 5mm.
- Very effective gold trap to hold large amounts and prevent its migration down the sluice.
- Vinyl fiber mats are very common in local markets as door mats. These are cheaper and less durable than the original brand, but they do the trick.

Clean Up:

- Carefully lift the mat from the sluice keeping it as level as possible or roll it over inside the sluice.
- Carry it over to the washing tub exercising care not to lose anything.
- Thoroughly rinse off all the concentrate with mat contained in tub.
- Rinse thoroughly up to the bottom of the mat as the heavier material settles at the bottom.
- After removing loose concentrate, beat carpet (with large pieces, between two persons) on water surfaces to remove trapped gold.

Advantages:

- Extremely durable.
- Easy to clean.
- Good for both coarse and fine gold.
- Does not trap too much slurry as other mats like blankets or woolen mats.
- Available locally as door mats.

Best Practice:

- Can use it ahead of other mats in a sluice due to its high efficiency.
- Always test for gold in the sluice tailings to decide on cleaning time.
- Always clean the vinyl fiber mat when it is time to do so.
- Slurry should not accumulate and clog the vinyl fibers as efficiency will decrease.

CORRUGATED RUBBER MATS

- Have riffles which are either vertical or inclined.
- Gold is trapped on the riffles which are about 5mm high.
- Commonly used as door or car mats.

Clean Up:

- Carefully lift the rubber mat from the sluice keeping it as level as possible.
- Carry it over to the washing tub exercising care not to lose anything.
- Thoroughly rinse off all the concentrate from the mat in the tub.
- Get the rubber mat back to the milling circuit.

Advantages:

- Easy to clean versus other materials like blanket mats or corduroy.
- Extremely good for both coarse and fine gold due to the riffle effect.
- Good for oxidized gold.
- Produces clean gold.
- Less labour in cleaning concentrate.
- Minimizes use of mercury.
- Locally available and cheap.
- Durable.

Best Practice:

- For angled riffles, the incline should face downstream for increased capacity.
- Mat can be in a series with other type of mats

RIFFLED WOOLEN MATS

- Good for gold recovery for both coarse and fine gold.
- When the riffles are packed with slurry, gold gets lost to the tailings.
- They are easy to clean compared to blankets.
- Tend to wear out very quickly and lose their pile, and with it the ability to trap coarser grains of gold.

Woolen mats have similar best practices as the other mats discussed above.

METALLIC RIFFLES

- The riffles are not mats but sit on the mats to enhance gold trapping abilities.
- Two types of metallic riffles used in gold processing are angle iron riffles and expanded metal riffles.
- Riffles are designed to slow down the movement of the heavier mineral through the sluice. They allow more time for gold to settle and be deposited on the mat.
- Useful for segregating the trapping of both coarse and fine gold. Riffles are effective in trapping coarse gold with the fine gold being captured further down the sluice.
- Different types of riffles used for recovering gold of different particle sizes.
- Riffles are placed on top of the mats and protect them and secure the gold.
- Angle iron riffles are used to trap coarse gold. Expanded metal riffles used for trapping fine gold.

Best Practice:

- They should be used in the first 1/3 of the sluice length. Some miners make the mistake of having the whole length covered by riffles. Riffles pack with slurry and cover the area for trapping, making the sluice efficiency drop.
- When the riffles are packed with slurry, the operation should be stopped and clean up done.

ACTIVITY

As a group, discuss the following questions:

1. Are sluices common in your mine site?

2. What is your experience using a sluice? Have sluices been used effectively?

3. What type of mats do you or others use at your site?

4. How can you improve your use of a sluice or sluicing at a mine site?

Motor Pumps

Motor pumps are used frequently in mining operations and are an integral part of both alluvial and underground mining.

NOTE TO THE FACILITATOR

The training should include a demonstration of best practices and hands-on learning. The trainer can include a demonstration of how a motor pump functions, its key features and parts, as well as important specifications such as power, head, and suction. A demonstration can include pump fueling and lubrication, supported by a local miner in charge of the motor pump operations.

In underground mining they are used for dewatering mine shafts. In alluvial mining, they are used for breaking loose ground, with a high-pressure jet used to break ground creating a slurry that flows onto a sluice for processing. They are also used to supply process water for sluicing.

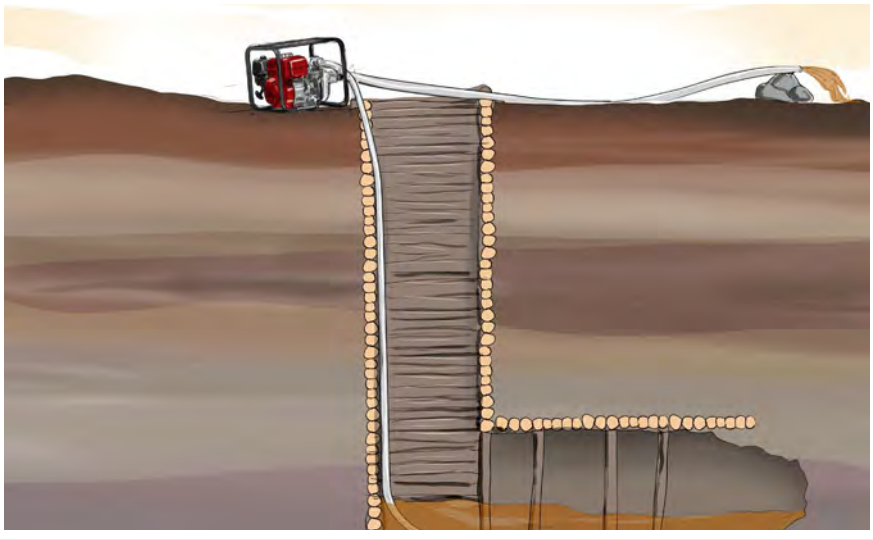

Image 29 : Motor pump used to dewater a mine shaft.

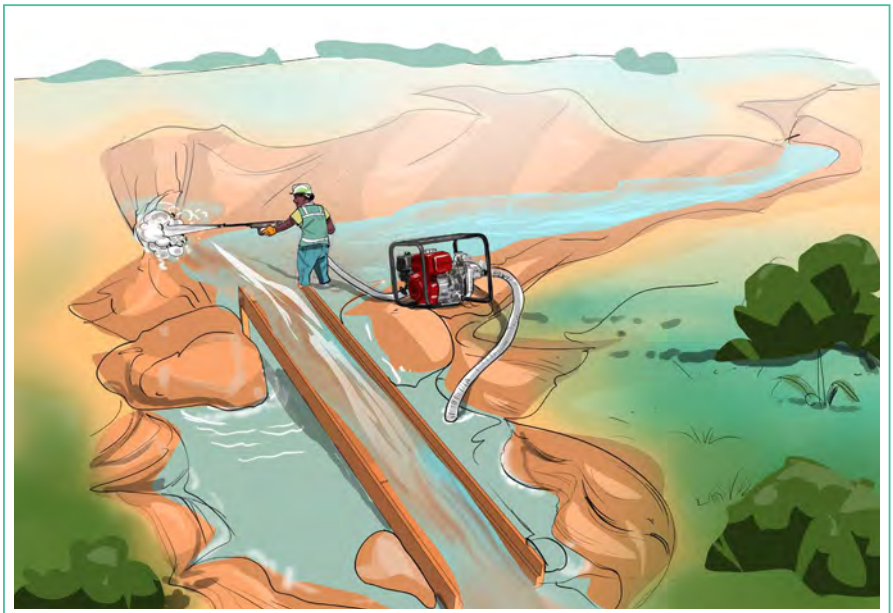

Image 30 : Motor pump used to break loose ground.

Image 31 : Motor pump supplies process water for sluicing.

Most motor pumps used in ASM use gasoline or diesel fuel. Some use electricity powered by generators, while others use compressed air.

Different sizes of motor pumps are used for different operations:

- **Clean or Slurry Water:** The correct type of motor pump should be used. There are clean water motor pumps and slurry motor pumps. For mining purposes, miners should buy slurry motor pumps or those that can be used in dirty water. This will preserve the life of the motor pump.
- **Motor Pump Size:** The head and the suction of the motor pump are important. The head is the vertical distance a motor pump can push water to, and the suction is the vertical distance a motor pump can pump water from. This is important if the water source is a distance from the place of operation. Miners need to measure the distances and use this information in making a choice on motor pump size.
- **Motor Pump Volume:** The volume of water per minute or hour that a motor pump can deliver will determine the size of the sluicing operation it can manage.

It is important to note the following when working with motor pumps:

- **Regular maintenance:** Working in mining and sandy areas damages pump impellers and seals. Regular maintenance will prolong the life of the motor pump.
- **Record of use:** Miners should keep a record of motor pump use and maintenance.
- **Responsible operator:** Someone should be designated to operate the motor pumps to ensure accountability and good storage. If too many operators use the same motor pump, sometimes there is no accountability when there is a problem.
- **Overworking:** A motor pump is a machine and needs to rest. Motor pumps can overheat when overused and develop mechanical faults. Use the motor pump as specified by the manufacturer.
- **Water processing:** When working with motor pumps, process water should be disposed of properly. Contaminated water should not be discharged to the environment. A discharge pond should be used to recycle processed water. If pumping is for dewatering mine shafts, the water can be directed to gardens to water crops or trees.

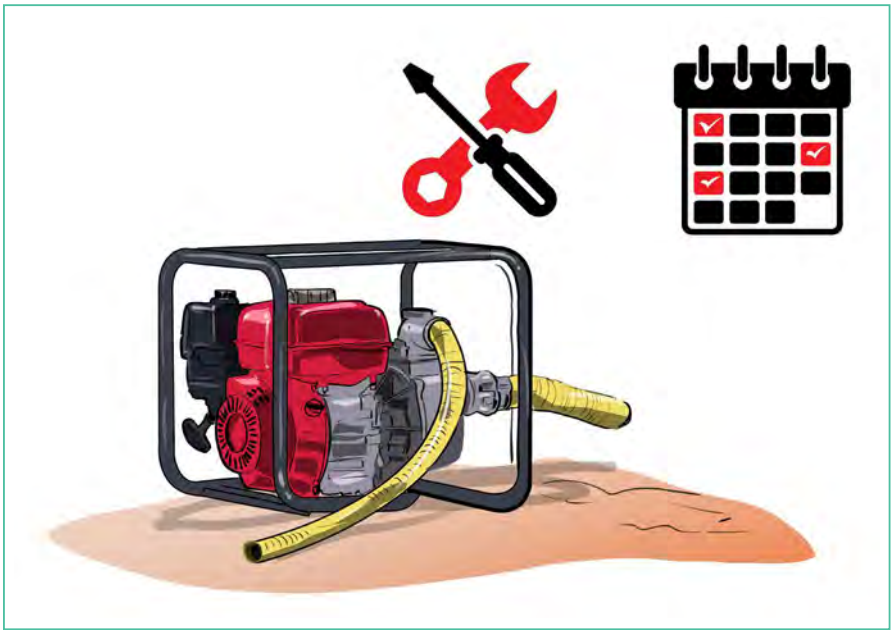

Image 32 : Regular maintenance will prolong the life of the motor pump.

ACTIVITY

As a group, discuss the following questions:

1. What are the common uses of motor pumps at your site?
2. Have you used motor pump effectively? Are you using the correct motor pumps?
3. How can you use motor pumps more effectively?
4. Who owns or manages the use of the motor pumps?
5. How can women come together to buy motor pumps?

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The **planetGOLD Uganda** project aims to reduce the use of mercury by supporting formalization of the artisanal gold mining sector and increasing access to finance. This will lead to adoption of mercury-free technologies and allow access to more responsible and traceable gold supply chains. The project is supported by the Global Environment Facility, led by the UN Environment Programme, executed by IMPACT in partnership with Uganda's National Environment Management Authority and the country's Ministry of Energy and Mineral Development under the Department of Mines.
www.planetgold.org/uganda

The **planetGOLD Côte d'Ivoire** project aims to reduce the use of mercury in the artisanal gold mining sector through a holistic, multi-sectoral and integrated formalization approach. The project also aims to improve access to traceable gold supply chains and financing for the adoption of sustainable, effective and practical mercury-free technologies. The project is supported by the Global Environment Facility, led by the UN Environment Programme, executed by the Centre Africain pour la Santé Environnementale (CASE) and IMPACT.
www.planetgold.org/cote-divoire

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