Food Security in Bangladesh: Improving with Modern Storage Facilities (such as Silo)

By

Kh. Musfikuzzaman

A thesis submitted to the Brac Institute of Governance and Development in partial fulfillment of the requirements for the degree of
Master of Arts in Governance and Development

Brac Institute of Governance and Development
BRAC University
July, 2025

Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing degree at BRAC University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I have acknowledged all main sources of help.

Student's Full Name & Signature:

_____

Kh. Musfikuzzaman

Student ID : 24372008

Approval

The thesis/project titled "Food Security in Bangladesh: Improving with Modern Storage Facilities (such as Silo)" submitted by

1. Kh. Musfikuzzaman, Student ID: 24372008

Of Summer, 2025 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Master of Arts in Governance and Development on 15/07/2025.

Examining Committee:

Supervisor:
(Member)

_____
Dr. Shaila Ahmed
Assistant Professor & Research Fellow
Brac Institute of Governance and Development (BIGD)
Brac University

Program Coordinator:
(Member)

_____
Mohammad Sirajul Alam
Senior Academic Coordinator
Brac Institute of Governance and Development (BIGD)

External Expert Examiner:
(Member)

_____
Mehnaz Rabbani
Chairperson, MAGD Dissertation Viva Panel
Director, Operations, Strategy, and Partnership
BIGD, BRAC University

Departmental Head:
(Chair)

_____
Imran Matin, PhD
Executive Director
BIGD, BRAC University

Ethics Statement

I so certify that, under the guidance of Dr. Shaila Ahmed, Assistant Professor & Research Fellow, Brac Institute of Governance and Development (BIGD), Brac University, I conducted my own research for this dissertation, " Food Security in Bangladesh: Improving with Modern Storage Facilities (such as Silo)".

The entire dissertation is written for academic purposes and is only intended to complete the requirements for the Master of Arts in Governance and Development degree.

I give permission for the BRAC Institute of Governance and Development (BIGD), BRAC University, to replicate this dissertation in whole or in part, for research purposes, by photocopying it or using another method upon request from other organizations or people.

I further affirm that neither this university nor any other university has previously accepted this paper, in whole or in part, for credit toward any degree or credential. The cited text and standards are duly acknowledged in the document that is presented to the BIGD, BRAC University administration.

Kh. Musfikuzzaman

Student ID: 24372008

Master of Arts in Governance and Development

Brac University

Abstract

Climate change, population pressure, and antiquated storage methods are all contributing factors to Bangladesh's increasing food security problems. The goal of this policy note is to eliminate inefficiencies, lower post-harvest losses, and improve disaster resilience by promoting the switch from conventional godowns to contemporary silo-based grain storage. Better grain quality, reduced loss rates, and more effective land use are just a few of the long-term operational and financial advantages that silos provide, despite their high initial cost. It's critical to increase the percentage of public storage that is currently silo-based to at least 50% by 2040, since it is at just 17.8%. Climate resilience and sustainable food security depend on infrastructure investment, workforce adaptability, and strategic policy support.

Dedication

To my Lovely wife for her motivation and support in completing this degree.

Acknowledgement

At the beginning I would like to express my greatest appreciation to almighty who has given me the knowledge and opportunity to perform my higher study in an internationally recognized institute like BRAC Institute of Governance and Development (BIGD), BRAC University. For duly performed my research I am indebted to many other persons and agencies.

Firstly, I would like to express my deepest gratitude and sincere respect to my honorable Supervisor, Dr. Shaila Ahmed, Assistant Professor & Research Fellow, Brac Institute of Governance and Development (BIGD), Brac University, Bangladesh for her appreciable guidance, continuous support, advice and unpredictable encouragement which helped me to overcome many difficulties related to my dissertation.

I would also like to express my profound gratitude to director of BIGD, Dr. Abdul Matin Sir, Mohammad Sirajul Islam, Coordinator- Academic and Training program for their valuable comments, suggestions and co-operation which have helped me to develop the research. Another person I would like to thank Mr. Rajon Sharif, who was very helpful through my journey at Brac University.

I am greatly thankful to the BRAC Institute of Governance and Development (BIGD), BRAC University for giving the approval to conduct my research.

Finally I am thankful to my colleagues of Directorate of Food for their kind support and inspirations.

Kh. Musfikuzzaman

Table of Contents

List of Tables

Executive Summary:

Bangladesh’s food security is under significant threat due to rapid population growth, climate vulnerability, limited arable land, and outdated food storage infrastructure. This Policy Note emphasizes the critical need for modernizing public food grain storage through the adoption of silo storage systems, which offer a viable solution to address existing inefficiencies and post-harvest losses.

Currently, about 70–75% of Bangladesh's 2.2–2.3 million metric ton public storage capacity relies on aging godowns that suffer from rodent attacks, moisture damage, poor aeration, and disaster vulnerability causing 5–10% post-harvest grain loss annually (world bank, 2021). In contrast, modern steel or concrete silos demonstrate under 0.5% grain loss, improved food quality retention, and better protection against pests, and extreme weather events. Their mechanized systems also streamline grain handling, reducing labor costs and increasing efficiency by up to five times compared to conventional warehouses (Ziauddin et al.2020).

Furthermore, silo storage is highly land-efficient occupying nearly one-fifth the area required by godowns for equivalent capacity-making them suitable for densely populated or urban settings (Islam, M. A., & Saha, R. 2021). Their vertical design, climate resilience, and potential for integration with national transport networks make silos a strategic investment.

To secure long-term food resilience, this policy note recommends transitioning towards modern silo-based infrastructure with adequate policy support, logistical integration, and investment, particularly under national strategies.

Background:

Bangladesh, historically part of the greater Bengal region, has experienced repeated food crises and famines that have shaped its socio-political and economic trajectory. The Great Bengal Famine of 1943, which claimed an estimated three million lives (Wikipedia), exposed the devastating consequences of food insecurity, inadequate storage, and poor distribution. Subsequent famines and food shortages—particularly in the aftermath of the 1971 Liberation War—further underscored the vulnerability of the region to food system failures triggered by conflict, natural disasters, and structural weaknesses in storage and logistics.

Despite significant progress in food production since independence, Bangladesh continues to face challenges in ensuring food security for its growing population. Key constraints include limited arable land, high population density, climate change impacts (e.g., floods, cyclones, salinity), and inefficient post-harvest grain management. Traditional food storage systems—primarily godowns—are outdated, prone to structural failures, and suffer from significant losses due to moisture, pests, and poor handling practices. These issues not only compromise the quality and quantity of food grains but also increase the risk of supply shortfalls during emergencies.

According to the data collected recently from the Storage Section of Directorate of Food, Bangladesh, The country has Public food effective storage capacity of around 21,39,138 Metric Ton, among them 17,68,138 MT are traditional Godowns and 3,81,000 MT are Silo storage system. So, modern storage facility for public food grain storage is only 17.81 Percent which is very low compared to other developing and developed nations. A project is running named Modern Food Storage Facilities Project by Government of Bangladesh with the fund given by World Bank to construct 7 steel Silos (capacity 4,87,000 Metric Tons) (Modern Food Storage Facilities Project,2025) at different parts of Bangladesh. More Storage facilities project should be initiated by Government of Bangladesh to ensure future Safety stock.

Furthermore, the traditional godowns among them many were constructed long ago need to demolish or needed major repairs. A recent study by IFPRI (Integrated Food Policy Research Program) found 633 LSDs, 13 CSDs, and 6 silos in all. Of these, it was discovered that 575 LSDs (91%), 11 CSDs (85%), and 5 silos (83%) were operational. Thus, at the time of the census, 58 LSDs (9%), 2 CSDs (15%), and 1 silo (17%) were found to be non-functional. Barisal division had by far the largest percentage of non-functional LSDs (36%). Rangpur division, on the other hand, does not have any non-functional LSD. Eleven CSDs (85%), four silos (67%) and 568 LSDs (90%), in total, needed some sort of repair; seven LSDs (1%) and one silo (17%) didn't need any. 31% of LSDs needed minor repairs, 30% needed moderate repairs, and 29% needed major repairs. Barishal and Chattogram had the lowest percentage of LSDs needing major repair (23% each), while Khulna had the highest percentage (35%). Two out of six silos (33%) and eleven out of thirteen CSDs (85%) needed extensive repairs (Razin Iqbal Kabir, Mohammad Yunus, Tofazzal Hossain, and Shahidur Rashid, 2019).

To address these issues Government of Bangladesh recently started a project of making conventional godowns in different areas of the country. It would be better if many of these facilities are modern silo storage system because silos are convenient in various aspects.

This Policy note will show that modern grain storage solutions, particularly silo systems, can play a transformative role in reducing post-harvest losses, improving grain quality, enhancing disaster resilience, and optimizing land use. Silos, with mechanized and airtight systems, address the key gaps in storage capacity, efficiency, and reliability—challenges that have long hindered Bangladesh’s food security efforts.

Modernizing food grain storage with silo systems becomes both a technological fix and a crucial strategic policy requirement. It provides a proactive solution to Bangladesh's ongoing food challenges, supporting national development objectives. In order to promote a systemic transition from traditional to silo-based storage infrastructure as the cornerstone of the nation's sustainable food security, the policy note thus builds on this backdrop.

Policy Options & Discussion:

The Government of Bangladesh is acting presently as per requirement to build new grain storage infrastructure but it should be continuous as many old traditional godowns are in the verge of demolishing. This will impact public food storage capacity. So, it is obvious to make policy of building public food grain storage at regular interval and increase national public food grain storage capacity. Now the question is, what kind of food grain storage system the government should develop?

There are two options in this regard:

1. Making Conventional Flat Godowns.
2. Building Modern Silo Storage system.

Conventional flat godowns are those in which food grain is stored in stacking system where as in Silo food grain is stored in vertically sealed metal or steel bins. Considering various factors and the different aspects of our country focusing on Modern silo storage system is way better than conventional godowns. This part of this policy note will describe why government should focus on building silo storage system.

Modern silo storage systems have a lot more land-use efficiency than old godown buildings, which is one of their main advantages. In Bangladesh, where a large population vies for a small amount of arable and developable land, land scarcity is a serious problem. Therefore, it is essential for sustainable infrastructure development to implement storage systems that optimize vertical space while minimizing land footprint.

Because grains are packed in bags across a vast floor area, traditional godowns usually need large horizontal expanses to store food grains. Depending on the design, height, and circulation area required for human handling, a typical godown could need 2,000 to 3,000 square meters of land to contain 5,000 metric tons of grain (Rakesh Kumar1, Nitesh Kushwaha2). The land required is further increased by the fact that these facilities require more room for sorting, stacking, and access roads for trucks and labour mobility.

On the other hand, silo storage systems are made for vertical integration, storing bulk grains in vertical columns using rectangular or cylindrical structures. Depending on its height and diameter, a single silo with a 5,000 metric tons storage capacity can take up less than 400 to 500 square meters of land (Rakesh Kumar1, Nitesh Kushwaha2). This implies that silos can store the same amount of grain with as little as one-fifth or one-sixth of the land space required for traditional godowns.

Modern concrete silos can be built on small plots of land, frequently inside or next to existing food depots, making the most of limited urban or semi-urban space, according to studies done by the World Bank and Bangladesh's Ministry of Food (2020). Additionally, because grains are kept and transported in bulk via conveyors and elevators, vertical storage facilities eliminate the requirement for large internal circulation and bag-handling spaces.

According to the data of Storage section of Directorate of Food and Development Project Proposal (DPP) of Modern Food Storage Facilities Project, the table given below will indicate the discussed fact.

Name of Storage Facilities	Capacity (Metric Ton)	Land required (Acre)
Chattogram Silo (2 Units)	2,14,300	24.61
Halishahar CSD, Chattogram	1,20,506	57.45
Ashugonj Silo (2 Units)	1,55,000	32.75
Tejgaon CSD, Dhaka	36,000	15.27
Mymensingh Silo	48,000	3.35
Mymensingh CSD	32,560	17.25

Table 1: Land required of Silo and CSD

So, from the comparison of land required by the existing food grain storage facilities we can clearly see that building Silo based food grain storage system is much more feasible in our context. Given Bangladesh's dense population and increasing urbanization, silo-based storage systems present a calculated way to address the problem of constructing infrastructure for food security in a space that is limited in size. They are especially well-suited for urban and peri-urban regions where space constraints make conventional godowns impractical because of their small land footprint.

Another highly considerable fact is Storage loss in traditional godowns. Bangladesh's food grain supply chain experiences substantial post-harvest losses, especially during storage. Several loss vectors, such as rodent infestations, moisture seepage, mould growth, and inadequate aeration, plague traditional storage in godowns. Depending on local conditions, food grain storage losses in conventional warehouses can vary from 5% to 10% annually, according to research by the Bangladesh Agricultural Research Council (BARC) and confirmed by the FAO.

The goal of contemporary silo storage systems is to completely prevent or significantly minimize these losses. Moisture, pests, and pollutants are kept out of airtight silos, especially those with integrated ventilation systems and hermetic sealing. Over periods longer than a year, the World Bank's pilot silo programs in Bangladesh showed less than 0.5 percent loss in stored grain. These devices minimize contamination and human handling errors by managing grains in a closed-loop setting (FAO, 2018).

From the research conducted by IFPRI analyzing the sample collected, the documented loss rates for rice are, on average, 0.229% for stacks that are 0–3 months old, 0.401% for stacks that are 3.1-6 months old, 0.635% for stacks that are 6.1–9 months old, and 0.686% for stacks that are older than 9 months. At three months, the measured rates average 0.519%, at one to six months,

0.658%, and at six to nine months, 0.817%. For stacks of wheat that are 0–3 months old and those that are older than 9 months, the situation is comparable. At 0–3 months, reported rates average 0.200%, and at 9 months or beyond, they average 0.718%. These numbers are in contrast to measured rates for the same storage duration of 0.378% and 1.085%. (Shahidur Rashid and Razin Iqbal Kabir, 2021).

In contrast to traditional godowns, silo storage systems provide an environment with almost no loss. Silos have been shown to dramatically lower losses from rodents, pests, humidity, and human handling errors (FAO, 2018). Long-term grain quantity and quality preservation is achieved by maintaining an ideal environment inside the silos through the use of hermetic sealing and aeration systems (Bayode Julius Olorunfemi1, a,*, Sunday Emmanuel Kayode2, b).

According to the data from Directorate of Food, In Fiscal year 2022-23, Godown loss reported in conventional godowns are given below;

Grain	**Godown Loss (Conventional Godowns)**	**Godown Loss (Silos)**
Paddy	540.993 Metric Tons	---
Rice	18034.09 Metric Tons	---
Wheat	1849.548 Metric Tons	000 Metric Tons
	Total: 20424.631 Metric Tons	**Total: 000 Metric Tons**

Table 2: Storage loss in Conventional Godowns & Silo

It is said in Development Project Proposal (DPP) that, Food grain losses in the conventional Godowns are hard to estimate. They range from 35,034 Metric tons in 1981-82 to 7,232 metric tons in 2007-08.

Keeping in mind the amount of food grain loss and the monetary value of the food grain, it is much more convenient to consider gradual shifting to modern silo based food grain storage system.

Another concerning issue is the quality of Food Grain. For public food distribution systems and general food security, stored grain must be kept in good nutritional and sanitary condition. Conventional storage facilities frequently have trouble controlling humidity and temperature, which creates an environment that, is conducive to nutrient deterioration, fungal growth, and insect infestation (Frontiers: Editorial). In humid regions like Bangladesh, aflatoxin contamination from Aspergillus flavus is a major worry when it comes to the storage of rice and maize. Grain integrity is maintained for extended periods of time by modern silos that are outfitted with temperature monitoring, aeration systems, and moisture control. According to research by Islam and Rahman (2021), grains kept in silos had less microbial contamination and a better nutritional value than those kept in godowns. Additionally, proactive quality control is made possible by the early detection of spoiling hazards made possible by the installation of real-time monitoring technology in contemporary silos. The high losses are partly due to deterioration

of grain quality and grain damage caused by infestation and spoilage in the traditional storage system. These issues can be addressed through proper drying, aeration, temperature control and fumigation as well as proper management control during the grain receiving, handling and distribution process (DPP, MFSFP).

Christian L. Berger identifies the comparative advantages of Silo over conventional warehouse in his article. His points are:

. Aeration systems for warehouses are inefficient and most of the time not considered resulting in a large percentage of losses and spoilage due to uncontrollable moisture damage.

· Impossible to control grain moisture and discoloration due to the lack or inefficient aeration maintenance system.

· Temperature monitoring for grain stored in warehouses is not available so no way to tell if the paddy is spoiling until too late.

· Warehouse storage is very labor intensive and cannot be automated.

· Paddy damage in warehouses due many manual manipulations.

· Rodent, bird and insect infestation are common in warehouse storage.

All of the above factors counteract the initial low cost of the warehouse storage, In the long run silos storage is more economical, more efficient and results in better product quality.

On the other side, Silos offer the following advantages;

· Effective and efficient aeration systems prevent paddy damage and discoloration resulting in better milling quality.

· Moisture is easily controlled thus preventing spoilage and discoloration.

· Temperature monitoring in the stored paddy is easy and automatic thus easy to prevent spoilage.

· Silo storage requires no manual labor.

· Paddy damage is minimized because manual manipulation is eliminated.

· Silos prevent rodent and bird infestation and fumigation is easily applied in silos to control insect infestation.

The silo maintained lower RH (16.1% below ambient) due to its airtight design, whereas Godown and CAP experienced higher RH fluctuations. Germination rates were best preserved in the silo (78.6% after 12 months), compared to significant declines in Godown (53.3%) and CAP (46.6%), attributed to earlier pest infestations. The findings demonstrate the GIC silo's

superiority in humid climates, emphasizing the need for improved pest control and airtightness in traditional storage methods (A. A. Sawant1, S. C. Patil2, S. B. Kalse2, N. J. Thakor3.).

Natural calamities including floods, cyclones, and intense rains can seriously damage food storage facilities in Bangladesh. Conventional godowns are susceptible to water intrusion, structural damage, and pest infestations during disasters since they are frequently built without disaster resilience in mind (ADB, 2017). On the other hand, silo systems, which are usually constructed with elevated structures and reinforced concrete, provide more resilience against these natural disasters. They are more dependable in guaranteeing continuous food availability during emergencies because of their location-specific designs and structural integrity.

Increasing silo storage capacity initiative will aid in adapting to the effects of climate change that are anticipated to arise due to Bangladesh's climate vulnerabilities. Bangladesh is particularly susceptible to natural calamities like floods, cyclones, droughts, and more because of its geographic location and dense population. These vulnerabilities have been exacerbated by global climate change, requiring more food grains to be stored under public sector control. (DPP, MFSFP, 2013) Apart from this it is recorded that huge amount of food grain has been declared Spoiled and non-distributable. According to data of the Central Laboratory section of Directorate of food, Tons of food grain has been wasted by recent natural calamities. Some figures are given below:

Natural Disaster Event	**Date**	**Storage Center**	**Spoiled food Grain amount (Metric Ton)**
Heavy rain of Sunamgonj	16-06-2022	Chatok, Mollikpur,Bishomvorpur,Dirai LSD	379.655
Heavy rain and hill slope flood of Lama, Bandarbon	08-08-2023	Lama LSD	96.808
Flash flood and heavy rain of Chattogram	22-08-2024	Habildarbasa LSD	79.412
Heavy rain and hill slope flood of Feni	21-08-2024	Fulgazi and Feni LSD	578.865

Table 3: Food grain wasted in conventional Godowns during recent natural calamities

Observing all these matters, it will be wise to increase Silo storage system in Public Food Grain Management and gradually shift the traditional warehouse to modern storage system in coastal areas of Bangladesh.

Automated grain handling technology, such as computerized monitoring systems, elevators, and mechanical conveyors, are installed in silo systems. These characteristics reduce human labor and time consumption by enabling quicker grain loading, unloading, and sorting (Ziauddin et al., 2020). Silos eliminate operational bottlenecks and improve inventory control and logistics management as compared to typical warehouses. This is especially crucial for disaster relief and emergency food delivery in Bangladesh.

By analyzing the data of Chattogram Silo it is found that the average grain receiving capacity per day of the silo is around 4000-4800 metric tons. In receiving very negligible number of labour is needed because it is semi mechanized process but the process needs a handsome amount of electricity from national grid. The average daily unloading capacity of Chattogram silo using all forms is around 3200-3500 metric tons. In this process maximum 100-120 numbers of labour is needed.

If we compare one of the busiest conventional godown i.e. Tejgaon CSD's Performance, then we can easily understand how effective the silos are. The average receiving capacity of this CSD is around 2500-2800 Metric tons using maximum godowns and labour needed in this work is around 180-240 persons. The average unloading capacity and labour requirement is almost the same as receiving. Electricity usage is much low as compared to Chattogram Silo but the cost of labour is high from Silo.

Because silo systems are so automated, fewer staff are needed for tasks like cleaning, loading, unloading, and grain monitoring. Traditional godowns employ unskilled and semi-skilled workers since they rely more on manual labour. These job prospects may be diminished by the move to silos, which would have an impact on livelihoods, particularly for low-wage workers (FAO, 2013).

On the other hand, Silos provide cost savings because of lower labour expenses and more operational efficiency, even though initial labour displacement is a worry. One possible use for these savings is to create jobs in other industries, such as silo building, maintenance, logistics, or quality control (World Bank, 2011). Skilled technicians and operators are required for silo systems. Though it may exclude unskilled workers until reskilling programs are implemented, this change promotes workforce up skilling and has the potential to eventually result in higher-paying positions (IFPRI, 2014).

The advanced materials, engineering design, automated systems, and safety infrastructure of modern grain silos necessitate a significant capital expenditure during the construction process. A single large-scale steel or concrete silo in Bangladesh might cost millions of dollars to install, including land acquisition, construction, equipment, and operator training. For a developing economy like Bangladesh, which has limited public resources and conflicting development goals like infrastructure, education, and health, this high upfront cost is particularly problematic.

If we analyze the cost of two projects running in Bangladesh of making silo storage and conventional godowns, we can see the higher initial investment is needed in making modern storage facilities like silos.

Project Name	Capacity (Metric Tons)	Cost (Lakh BDT)
Modern Food Storage Facilities Project	4,87,000	3,96,089
Construction of New Food godowns with ancillary facilities in different strategic locations across the country	1,38,000	81,450

(Source: DPP Of the two projects)

Table 4: Capacity and cost of Silo construction & godown construction project

The long-term advantages of silos, however, exceed the expenses, even with the substantial initial outlay. According to cost-benefit analyses (CBAs), silos provide effective grain handling and distribution, retain grain quality, and drastically lower post-harvest losses (about 10–15% in conventional godowns), particularly in times of emergency or disaster. Price stability and national food security are supported by this efficiency.

According to a World Bank report titled *"Bangladesh Modern Food Storage Facilities Project (MFSP)"*, the economic internal rate of return (EIRR) for silo construction is above 20%, indicating strong economic viability. Benefits include:

- Reduced post-harvest loss (by 10–15%)
- Better quality preservation for up to 2–3 years
- Reduction in pest and fungus damage
- Efficient handling, reducing labor and transport costs
- Better disaster resilience (earthquake, flood-resistant)

The same project estimated that for every BDT 1 invested in silos, the return over the long term was BDT 2–3 in saved grain, reduced imports, and improved food security (World Bank, 2013).

Political economy dynamics, fragmented agency cooperation, and bureaucratic inertia have all contributed to Bangladesh's sluggish adoption of silo systems, despite their obvious operational benefits. Procurement complexity, a lack of technical expertise, and opposition from

stakeholders who profit from the current labor-intensive system are the main causes of delays in large capital investment projects. Financing is still a major obstacle; to lessen this load, public-private partnerships, concessional loans, or foreign assistance may be investigated. Furthermore, organized retraining programs and job guarantees in associated industries—like silo system construction, maintenance, and logistics—could lessen the socioeconomic effects of labor displacement. To guarantee long-lasting change, a transition strategy that incorporates policy alignment, community involvement, and workforce up skilling is necessary.

Regardless of their benefits, silos shouldn't completely replace godowns unless a transitional strategy is in place. In places without the infrastructure necessary to sustain extensive silo operations, godowns continue to play a crucial role. The best course of action would be a hybrid strategy that prioritizes silo growth in strategic, high-risk, or high-density areas while maintaining and updating important godown facilities. As a result, policies shouldn't just support silos without taking into account the godowns existing function. Informed by labor impacts, land use efficiency, cost-benefit analysis, and resilience planning, a progressive, evidence-based transition will guarantee that Bangladesh creates a storage system that is not just contemporary but also inclusive, flexible, and sustainable.

Despite their continued significance in the national food reserve system, godowns urgently need to be reformed due to their shortcomings in terms of capacity utilization, grain loss, quality preservation, and disaster resilience. By lowering post-harvest losses, increasing operational effectiveness, preserving grain quality, and offering strong infrastructure against climate challenges, silos provide a contemporary substitute that improves food security.

Recommendation:

1. As Bangladesh is one of the most vulnerable countries in the world and its population is a huge burden to its capacity, so, it is obvious that Bangladesh should focus on increasing the food storage capacity.
2. Increasing food grain storage system will help to strengthen the food security of Bnagladesh. So, Consideration of building storage infrastructure should be top priority of Government of Bangladesh.
3. By 2035, Bangladesh should increase its food storage capacity to 32 lakh metric tons from 21.40 lakh metric tons at 2025.
4. The percentage of Silo based storage system in Public food storage management of Bangladesh should be at least 50 percent by 2040 which is 17.8 percent at present.

Implementation Plan:

1. Government should fixed 15-20 percent of his Food department budget in making storage infrastructure by curtailing portions of food grain distribution such as, OMS, rationing, TR etc.
2. Despite high initial cost Government must take 80 percent projects of making silo based storage system and 20 percent of traditional godowns.
3. As Bangladesh does not have a Silo in Sylhet division and it is geographically vulnerable to disasters & also rice producing region of the country, so, Government must be serious of making 1, 00,000 metric ton capacity rice silo in Sunamgonj district.
4. Government should take initiative of making 1, 50,000 metric tons capacity wheat silo in Payra port as wheat is procured mostly from other countries.
5. During the demolishment of old traditional godowns, modern silo based storage infrastructure should replace them.

Conclusion:

Bangladesh must give top priority to switching from traditional godowns to contemporary silo-based grain storage facilities in order to ensure long-term food sustainability. Conventional storage facilities are antiquated, ineffective, and vulnerable to disasters, moisture, and pests, which can cause significant grain loss. On the other hand, silo systems provide cutting-edge solutions that guarantee improved food quality, lower post-harvest loss (less than 0.5%), increased resilience to disasters, and substantial land-use efficiency—all of which are crucial in a nation with a dense population.

Despite silo construction's high initial cost, cost-benefit analysis and long-term operational efficiency make the investment worthwhile. Silos improve food safety and supply chain dependability by lowering labour costs, improving grain handling through automation, and maintaining nutritional content. In a country like Bangladesh that is prone to climate change, its ability to withstand the effects of climate change also helps with disaster preparedness.

It is critical to scale up to at least 50% of storage capacity by 2040, as silos currently only account for 17.8% of total storage capacity. It is necessary to implement strategic policy changes, make ongoing investments, and gradually replace deteriorating godowns with silos. By doing this, Bangladesh may lessen its reliance on food imports, improve its food security system, and create a future agricultural infrastructure that is resilient to climate change.

References:

- World Bank. (2021). *Strengthening Food Security in Bangladesh: Infrastructure and Policy Reforms*.
- Ziauddin, M., Hossain, M., & Kabir, A. (2020). Performance Evaluation of Silo Storage in South Asia: A Case Study of Bangladesh. Asian Journal of Postharvest Management.
- Islam, M. A., & Saha, R. (2021). Comparative Study on Land and Operational Efficiency of Godowns vs. Silo Structures in Bangladesh. Journal of Infrastructure Planning and Development.
- Bengal Famine, Wikipedia
- Directorate of Food's Data
- Public food grain storage facilities in Bangladesh An assessment of functionality, repair needs, and alternative usage Authors: Razin Iqbal Kabir, Mohammad Yunus, Tofazzal Hossain and Shahidur Rashid
- World Bank (2020). Feasibility and Technical Assessment of Modern Silo Storage Facilities in South Asia.
- A Review Study on Silos for Safe Storage of Food Grain Rakesh Kumar1, Nitesh Kushwaha2. Ahmed, N., Rahman, M., & Sultana, S. (2019).
- Assessment of Post-Harvest Losses in Public Food Storage in Bangladesh. Journal of Agricultural Policy Research.
- FAO (2018). Modern Grain Storage Systems: A Review of Technologies and Practices. Food and Agriculture Organization of the United Nations.
- Public sector food grain storage losses in Bangladesh An assessment of current losses and the identification of solutions to reduce them Shahidur Rashid and Razin Iqbal Kabir.
- Post-Harvest Loss and Grain Storage Technology- A Review Bayode Julius Olorunfemi1,a,*, Sunday Emmanuel Kayode2,b
- Frontiers: Editorial| Food storage, spoilage and shelf life: Recent Development and Insights
- Islam, M. M., & Rahman, M. (2021). Grain Quality and Safety in Bangladesh: Role of Modern Storage Facilities. Journal of Food Protection and Safety.
- Development Project Proposal (DPP), Modern Food Storage Facilities Project.
- Christian L. Berger, 2018: Benefits of Silo's versus Warehouse.
- Effect of temperature, relative humidity and moisture content on germination percentage of wheat stored in different storage structures A. A. Sawant1, S. C. Patil2, S. B. Kalse2, N. J. Thakor3.
- Asian Development Bank (ADB). (2017). *Disaster Risk Management in Public Infrastructure: Bangladesh Food Storage Case*.
- Ziauddin, M., et al. (2020). *Performance Evaluation of Silo Storage in South Asia: A Case Study of Bangladesh*. Asian Journal of Postharvest Management.
- FAO (2013). *Grain Storage Systems: Technical Report*, notes that mechanized systems like silos reduce labor input by 30–50% compared to conventional warehouses.
- World Bank (2011). *Bangladesh Modern Food Storage Project* states that silo storage significantly lowers operational costs and grain losses, enhancing food system efficiency.

- IFPRI (2014). *Post-Harvest Losses in Developing Countries*, highlights the need for training to bridge the skill gap caused by modern storage adoption.
- The World Bank. (2013). *Bangladesh: Modern Food Storage Facilities Project (MFSP)*, Project Appraisal Document. [World Bank Report No: 73984-BD].

Appendix A: Dissertation Proposal

Title:

Food Security in Bangladesh: Developing with Modern Storage Facilities (such as Silo).

Introduction and Background

Although historically, agriculture is the backbone and primary income source of Bangladeshi people, food security is a critical issue in Bangladesh. Despite modern development in agriculture, our country still faces several challenges in ensuring the food supplement for our nation. Ahmed et al. (2023) explain how, despite scientific improvements in agriculture, around 30–60% of food is wasted or lost worldwide. According to Hossain et al. (2024), Bangladesh's food waste was 40.86 million tons in 2021 and is expected to reach 62.82 million tons in 2043. Modern storage facilities, like artificially controlled temperature storage, cold chain systems, hermetic storage, and grain silos have proven effective in other developing nations but remain underutilized in Bangladesh. This research aims to investigate thoroughly how modern storage adoption can reduce food waste, improve food supply chain systems, and ensure food security for everyone in our country.

The majority of Bangladeshis, 70% of whom reside in rural, are farmers (Hobbs et al., 2023). Since agriculture is a major contributor to economic growth, its advancement is essential to our economic expansion. Falco et al. (2018) identified agriculture as a cornerstone for socio-economic progress and stability, with agriculture-related industries contributing 4% to the global GDP in 2018 and over 25% in certain emerging economies.

Agriculture is critical for ensuring food security, especially in emerging economies. Issues such as rising food demand and declining agricultural productivity have prompted researchers to focus on innovations. Food security is increasingly seen as vital for promoting sustainable development. Storage systems are one of the most vital issues to be addressed for food security.

The study investigated by Shihab & Ahamed, 2018, shows how paddies are stored in Mymensingh, Bangladesh. They investigate storage types and capacities. Here they also discussed the challenges like pest infestations and grain losses.

The farmers of Bangladesh use traditional storage systems for food preservation. This led to post harvest loss. In large scale Bangladesh Government stores food grain in traditional godowns and Silos. According to the information from Directorate of Food, Bangladesh, this country has a grain storage capacity of 18, 97,570 Metric Tons. Among the storage capacity, 2, 75,000 Metric tons are Silo storage and rest is Conventional Godown storage. Apart from this storage, Mill owners and businessmen have their own conventional grain storage.

Food storage practices play a critical role in managing everyday uncertainties and crises, reflecting historical and contemporary shifts in how households prepare for the future. The researcher, Marshall, M. (2023), examines the food storage process in Sweden, their preparedness for both daily life and how they handle unexpected crises.

Another concerning issue is that Bangladesh continues to rank among the nations most exposed to the effects of climate change, especially in terms of how it affects rural areas. Approximately 16 percent of Bangladeshis are currently living below the poverty line, and 80 percent of them reside in rural areas that are particularly susceptible to disasters linked to climate change (World Bank, 2022). The country loses about 1.5 % of its gross domestic product yearly due to climate change effects with the agrarian sector being the most affected region (Roy et al., 2022). So, Food storage system modernization and food security are huge concerns for future Bangladesh and Government must act accordingly for sustainable development of Bangladesh.

Relevance of the Policy Issue to Contemporary Challenges

One of the world's most densely inhabited nations is Bangladesh and the cultivation land is becoming scarcer day by day. So, food security will be the main factor of concern in coming days.

Each year, the nation consumes 4 million tons of wheat and 30 to 34 million tons of rice on average. Even though the nation produces enough rice on its own most of the time, it still imports a lot of wheat to make up the difference in consumption (about 30% from the government and 70% from the private sector). The Public Food Distribution System distributes locally procured grain in addition to government imports, which are primarily lesser grades of wheat (and coarse rice in emergency situations) (dg food ,2015).

The imported wheat stored in the Silos by Government of Bangladesh and locally procured rice and wheat stored in conventional godowns. The problems of conventional godowns are the food grain quality worsens within 6 months and it requires large land to construct conventional godowns. The quality of food grain remains good for about 2-3 years in the silos and land required to make silos is little in comparison to conventional godowns.

In context of policy formulation, Government has to procure good grain as per its storage capacity as Bangladesh is climate vulnerable countries. But problem is due to the degradation of grain quality in conventional godowns Government has to distribute the food grain in different channel in every year. If Government is taking the policy to increase modern food storage capacity, then the procurement and distribution will be less and expenditure of food grain purchase will be lower than today.

Although, Government of Bangladesh is completing a project with the help of world Bank of constructing 7 Silos, with storage capacity of 3,87,000 Metric Tons but it will be still a little.

Bangladesh has only around 17% of modern storage system and it should be at least 50% in context of food security and climate vulnerability.

Objective of the Study

The primary objective of this research is to examine "Food security in Bangladesh and how we can improve with modern storage facilities." In pursuit of this main goal, several specific objectives have been outlined:

1. Analyze the role of modern storage facilities (silo's) in addressing food security challenges in Bangladesh

2. Evaluating existing storage infrastructure and government initiatives in Bangladesh.

Research question:

How can modern storage solutions such as silos enhance food security in Bangladesh?

Proposed Approach:

The study will adopt a mixed-methods approach:

Secondary Data Review:

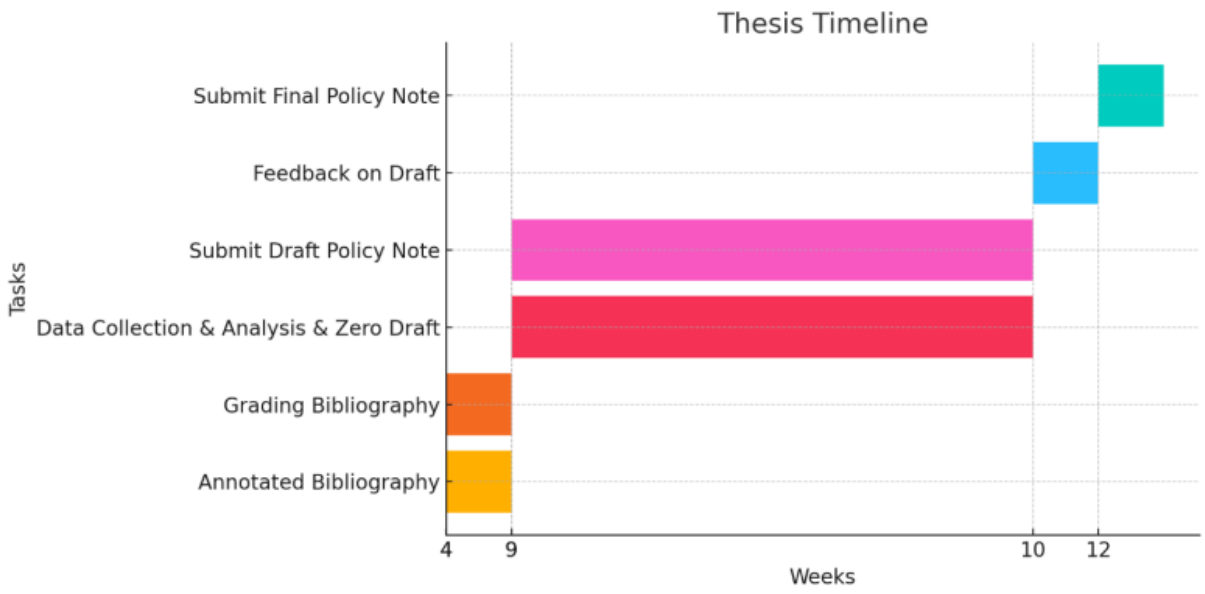
- Review secondary data such as research paper, journals, and artistic sourcing from Google scholar, research gate etc.
- Collect information from Ministry of food, Directorate of food, Ministry of Agriculture,

etc. organization of government of Bangladesh

Case Study Analysis:

- Analyze examples of countries that have successfully implemented silo-based food storage systems.
- Focus on case studies from India, Vietnam, and other relevant nations.

Tasks and Timeline



Annotated Bibliography (Week 4–5):

- Creating a list of articles and papers which we need to do this research

Grading Bibliography (Week 5–6):

- Evaluation submitted paper list

Data Collection & Analysis & Zero Draft (Week 6–9):

- Gathering data, analyzing it, and preparing the initial draft of the dissertation.

Submit Draft Policy Note (Week 9–10):

- Submission of the initial draft of policy note.

Feedback on Draft (Week 10–11):

- Feedback is provided on the submitted draft to guide further revisions.

Submit Final Policy Note (Week 11–12):

- The final version of the policy note is submitted after incorporating feedback.

Conclusion

Currently, food security is becoming a critical concern for the Bangladeshi economy. This proposal highlights the urgent need for modern storage facilities, such as silos and cold storage, to reduce waste, ensure food availability, and improve overall food security. By integrating advanced technologies and robust policy frameworks, Bangladesh can ensure a more resilient and sustainable food system for its growing population.

References

1. Mohammed, M., Riad, K., & Alqahtani, N. (2022). Design of a Smart IoT-Based Control System for Remotely Managing Cold Storage Facilities. *Sensors*, *22*(13), 4680. https://doi.org/10.3390/s22134680
2. Khatri, P., Kumar, P., Shakya, K.S. *et al.* Understanding the intertwined nature of rising multiple risks in modern agriculture and food system. *Environ Dev Sustain* **26**, 24107–24150 (2024). https://doi.org/10.1007/s10668-023-03638-7
3. Tushar, S. R., Alam, M. F. B., Zaman, S. M., Garza-Reyes, J. A., Bari, A. B. M. M., & Karmaker, C. L. (2023). Analysis of the factors influencing the stability of stored grains: Implications for agricultural sustainability and food security. *Sustainable Operations and Computers*, *4*, 40-52. https://doi.org/10.1016/j.susoc.2023.04.003
4. Falco, E., Garda, E., & Shahab, S. (2024). Transaction costs of implementing the transfer of development rights program in Milan. *Planning Practice & Research*, 1-19.
5. Gope, S. N., Ali, M. R., Awal, M. A., Ahamed, S., Alam, M. M., Saha, C. K., & Winter-Nelson, A. E. (2024). Hermetic Cocoon for Large-scale Paddy Seed Storage in Bangladesh. *Journal of Agricultural Machinery and Bioresources Engineering*, *8*(1), 1-8.
6. Marshall, M. (2023). Prepared for a crisis and the unexpected: Managing everyday eventualities through food storage practices. *Food, Culture & Society*, *26*(2), 305-326.

7. Mohammed, M., Riad, K., & Alqahtani, N. (2022). Design of a smart IoT-based control system for remotely managing cold storage facilities. *Sensors*, *22*(13), 4680.
8. Ahmed, M., Asim, M., Ahmad, S., & Aslam, M. (2023). Climate change, agricultural productivity, and food security. In *Global agricultural production: Resilience to climate change* (pp. 31-72). Cham: Springer International Publishing.
9. Hossain, M. S., Das, B. K., Das, A., & Roy, T. K. (2024). Investigating the techno-economic and environmental feasibility of biogas-based power generation potential using food waste in Bangladesh. *Renewable Energy*, *232*, 121017.
10. World Bank (2022) *Key highlights: Country climate and development report for Bangladesh, World Bank*. Available at: https://www.worldbank.org/en/news/feature/2022/10/31/key-highlights-country-climate-and-development-report-for-bangladesh (Accessed: 25 December 2024).
11. Roy, B., Penha-Lopes, G. P., Uddin, M. S., Kabir, M. H., Lourenço, T. C., & Torrejano, A. (2022). Sea level rise induced impacts on coastal areas of Bangladesh and local-led community-based adaptation. *International Journal of Disaster Risk Reduction*, *73*, 102905.
12. https://dgfood.portal.gov.bd/sites/default/files/files/dgfood.portal.gov.bd/page/cb9f6c96_eeef_486e_adb9_c7b3e786f761/Final%20TOR%20for%20Integrated%20Research%20Program-08-06-01-15.pdf

Appendix B: Annotated Bibliography

1. Public sector food grain storage losses in Bangladesh An assessment of current losses and the identification of solutions to reduce them Shahidur Rashid and Razin Iqbal Kabir.

Summary:

The paper titled *"Postharvest Losses in Bangladesh: Insights from Nationally Representative* The International Food Policy Research Institute (IFPRI) uses data from a nationally representative 2018 survey to examine storage losses among Bangladeshi producers of wheat and rice. It reveals that while nearly all farm households store their grain postharvest, the actual quantitative storage losses are low, averaging less than 1% of production. The study highlights that these low losses are largely due to farmers using improved storage technologies like plastic drums, metal bins, and polythene-lined earthen pots. Interestingly, the paper finds that qualitative losses—such as changes in color, taste, and smell—are more prevalent than quantitative ones and can negatively impact market value and consumption. Women are often responsible for storage and are particularly affected by these quality changes. The study also debunks common assumptions that pests are a significant source of loss during storage, showing that pest-related issues are infrequent. The authors argue that while improved storage technologies help minimize losses, further investment in better handling, drying, and packaging could reduce qualitative degradation. The findings suggest that interventions should focus more on maintaining grain quality and improving market access rather than solely emphasizing quantity preservation.

2. Metal silo grain storage technology and household food security in Kenya Zachary Gitonga, Hugo De Groote and Tadele Tefera.

Summary:

The document explores how household food security is affected by metal silo grain storage technology in emerging nations. Traditional post-harvest storage methods, such as bags and local granaries, often result in significant grain losses due to pests, mold, and spoilage. Metal silos, made from galvanized steel and hermetically sealed, offer an effective solution by protecting stored grain from moisture, insects, and rodents. The study highlights that households using metal silos experience reduced post-harvest losses, improved food availability throughout the year, and increased income from selling surplus grain. Additionally, the technology promotes food safety and enhances household resilience to food shortages. Adoption challenges include the initial cost of silos, lack of

awareness, and limited access to credit. However, training programs, community-based initiatives, and support from NGOs and governments can boost adoption rates. Overall, metal silos significantly contribute to food security by minimizing losses, improving storage conditions, and supporting sustainable agricultural practices.

3. A Review Study on Silos for Safe Storage of Food Grain Rakesh Kumar1, Nitesh Kushwaha2.

Summary:

The paper titled Rakesh Kumar and Nitesh Kushwaha's "A Review Study on Silos for Safe Storage of Food Grain" provides an analytical overview of silo structures used for grain storage, emphasizing their critical role in industrial storage and food security. Silos are large containers designed to hold bulk materials like food grains, and their structural failure can result in significant financial losses due to material wastage and halted operations. The study reviews various research efforts on silo design, structural behavior, and load analysis, particularly in steel and reinforced concrete silos. It highlights the complexity of hopper and transition junction designs, material flow behavior, and load patterns under different conditions such as seismic forces. Finite element modeling and experimental methods were employed by researchers to simulate and validate design approaches. A comparative design analysis of silo supporting structures using RCC and steel was also discussed. The paper identifies gaps in current modeling techniques and the need for advanced material behavior models. The conclusion emphasizes the importance of accurate load calculations, structural design refinements, and unified design procedures to improve silo safety and efficiency. This review underlines the necessity for continued research and innovation in silo construction to ensure durable and safe storage systems.

4. Effect of temperature, relative humidity and moisture content on germination percentage of wheat stored in different storage structures A. A. Sawant1, S. C. Patil2, S. B. Kalse2, N. J. Thakor3.

Summary:

The study looked at how temperature, relative humidity (RH), and moisture content affected the germination of wheat in three different types of storage structures: cover and plinth (CAP) storage, godown, and galvanized iron corrugated (GIC) silo—in India's humid Konkan region over 12 months. Moisture content increased during the rainy season (peaking at 17.08–17.25%) before declining slightly in summer, while temperatures rose in all structures (silo: 42.9°C, Godown: 32.31°C, CAP: 39.94°C) due to insect activity and grain respiration. The silo maintained lower RH (16.1% below

ambient) due to its airtight design, whereas Godown and CAP experienced higher RH fluctuations. Germination rates were best preserved in the silo (78.6% after 12 months), compared to significant declines in Godown (53.3%) and CAP (46.6%), attributed to earlier pest infestations. The findings demonstrate the GIC silo's superiority in humid climates, emphasizing the need for improved pest control and airtightness in traditional storage methods.

5. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) REPORT FOR THE CONSTRUCTION OF GALVANIZED CORRUGATED FLAT BOTTOM STEEL SILO WITH RCC FOUNDATION AND its ANCILLARY WORKS AT NARAYANGANJ SILO SITE.

Summary:

The goals, scope, and possible effects of the project are described in the Environmental and Social Impact Assessment (ESIA) study for the construction of galvanized corrugated flat-bottom steel silos with RCC base and auxiliary works at the Narayanganj Silo Site in Bangladesh. The project, funded by the World Bank, aims to enhance food grain storage capacity to address food security challenges exacerbated by climate change and natural disasters. The report details the baseline environmental conditions, including climate, noise levels, water resources, and soil quality, and identifies potential impacts during pre-construction, construction, and operational phases. Mitigation measures are proposed to address issues such as noise, dust, water contamination, and traffic congestion. The project is classified as Category B under World Bank safeguards, with no significant land acquisition or resettlement impacts. Public consultations highlighted community support for the project, emphasizing employment opportunities and local economic benefits. The report concludes with recommendations for environmental and social management plans, grievance redress mechanisms, and institutional arrangements to ensure sustainable implementation. Overall, the project is deemed environmentally sound and socially beneficial, provided the recommended mitigation measures are adhered to.

6. Private investments in modern food grain storage in Bangladesh An economic feasibility analysis and potential role for the public sector Reajul Alam Chowdhury, Md. Monjurul Alam, Md. Rostom Ali, Md. Abdul Awal, Shahadat Hossain, Prasanta Kumar Kalita, Chayan Kumer Saha and Alex Winter Nelson.

Summary:

Based on the provided economic feasibility analysis of private investments in modern food grain storage in Bangladesh (Chowdhury et al., 2021), the study concludes that current seasonal price variations are insufficient to make private investment in modern storage technologies like silos or hermetic cocoons profitable. While these technologies reduce losses, their high costs outweigh the benefits at observed prices. Conventional warehouse storage, despite higher losses, remains more financially viable. Substantial public sector co-investment would be needed to incentivize private sector adoption of modern storage, particularly for commercial storage as an independent activity, although a smaller investment might encourage existing millers to upgrade their storage methods. The potential for a price premium on higher-quality grain from modern storage could significantly alter these findings.

7. Food grain losses associated with indigenous storage methods and development of storage facilities for food security 1Chattha, S.H., 2*Hasfalina, C.M., 3Mirani, B.N., 2Mahadi, M.R. and 2Lee, T.S.

Summary:

The study investigates the deterioration of wheat grains stored using traditional and designed methods over 12 months. Results showed that grains stored in straw-clay bins retained maximum protein, lipid, ash, and starch. On the other hand, the highest amounts of fungi, aflatoxin, dampness, and insect damage were seen in room storage. According to the study, room structures, bulk covering, and earthen bins are less successful than straw-clay, concrete block, and Ferro cement bins at preserving the quality of wheat. The adoption of these designed bins can reduce grain losses, enhance food security, and improve the national economy, especially in developing countries.

8. Case study on how Double Lid (DL) Silos improve grain storage among farmers in semi-arid area by 100% Isaac Muringih- Researcher Developer

Summary:

The case study investigates the effectiveness of Double Lid (DL) silos for grain storage among farmers in semi-arid regions of Kenya, revealing a 100% prevention of grain infestation by weevils and rodent destruction. The study, conducted in the Thura River Basin, Embu County, involved 23 farmers and the construction of seven DL silos. The technology is locally available, economically viable, and easy for farmers to implement.

Key findings:

DL silos eliminate grain destruction, enhance security, and boost farmer income.
The silos can hold large grain quantities without chemical application.
Farmers using DL silos can potentially improve their living standards by 40%.
The study emphasizes the importance of exhausting oxygen and using desiccants inside the silos, along with proper construction to minimize moisture.
The next season, 2012–2013, saw a 120% increase in grain yield from farmers that implemented DL silo grain storage.
DL silos solve problems related to security, losses, and exploitation, contributing to grain drain in 30 to 40%.
The silos are constructed using Ferro cement, featuring a desiccant chamber, candle tray for oxygen exhaustion, and a slanting bottom for easy grain removal. The case study concludes that DL silos are ideal for small and medium farmers in food-scarce regions, promoting food sustainability and agricultural development.

9. Public food grain storage facilities in Bangladesh An assessment of functionality, repair needs, and alternative usage Authors: Razin Iqbal Kabir, Mohammad Yunus, Tofazzal Hossain and Shahidur Rashid

Summary:

This paper assesses the upkeep needs and operational efficiency of Bangladesh's public food grain storage facilities. The study, which was commissioned by the Directorate General of Food, included a census of 653 facilities, including local supply depots (LSDs), central storage depots (CSDs), and silos. Key findings reveal an aging infrastructure with significant discrepancies between rated and usable capacities, highlighting the need for strategic policy decisions regarding repairs, modernization, or divestment of non-functional facilities. The report provides detailed repair estimates and recommendations for dismantling or retaining non-functional facilities based on demand assessments and consultations with food officials.

10. Post-Harvest Loss and Grain Storage Technology- A Review Bayode Julius Olorunfemi1,a,*, Sunday Emmanuel Kayode2,b

Summary:

This research paper reviews technological advancements in post-harvest grain storage techniques to mitigate significant losses, estimated at 20-40% globally. Food security and

farmer revenue are negatively impacted by significant quantitative and qualitative losses caused by the inefficiency of traditional measures, such as cribs and brick bins, against mold and insects. Better technologies provide workable answers, such as metal silos, hardwood silos, and Purdue Improved Crop Storage (PICS) bags. If moisture and temperature are controlled, metal silos efficiently minimize insect and pathogen losses, while PICS bags stop aflatoxin buildup and moisture migration. However, condensation in metal silos remains a challenge. The paper also explores improved traditional storage methods like reinforced brick and cement structures, and modern techniques such as Volcani Cubes and the Frig-O-Dry system, emphasizing the importance of controlled atmospheres and computer-aided monitoring for optimal grain preservation. The study highlights the need for cost-effective, durable, and scientifically managed storage technologies to ensure long-term grain quality and enhance food security, particularly in developing countries.

11. Returns to improved storage and potential impacts on household food security and income: evidence from Tanzania B.H. Kotu[1]; A. Abass[2]; I. Hoeschle-Zeledon[3]; H. Mbwambo[4]; M. Bekunda[2]

Summary:

In contrast to polypropylene bags, this study examines the economic feasibility of better maize storage in Tanzania, with a particular emphasis on Purdue Improved Crop Storage (PICS) bags and iron silos. Three districts' worth of secondary sources, household surveys, and on-farm trials provided data for the study.

According to the results, PICS bags maximize returns in January when maize is sold during the lean season. Size and location affect the profitability of metallic silos; some areas can support larger silos (1.5t and 2t), while others cannot. By extending their grain supply by three to four weeks, PICS bags greatly improve household food security, especially for net-buyer households. Improved techniques for market-oriented storage significantly boost farmer revenue.

The study refutes the hypothesis that high storage losses cause the "sell low, buy high" behavior observed among smallholder farmers. Other factors, such as liquidity constraints, are likely responsible. Sensitivity analysis reveals that changes in opportunity cost of capital, maize prices, storage costs, and storage lifespan significantly impact the economic feasibility of different storage options. The findings suggest promoting PICS bags to improve food security and income for Tanzanian farmers.

12. Review on Improved Grain Storage Techniques Such as Grainpro, Purdue Improved Crop Storage (PICS) Bag, and Metal Silo Kumsa Negasa Andersa1*, Hayat Hassen Mohammed1, Tolina Kebede Regasa2, Zenaba Kadir Abdisa1 and Endris Hussen Ahmed

Summary:

Grainpro bags, Purdue Improved Crop Storage (PICS) bags, and metal silos are the main topics of this review study, which looks at better grain storage methods to reduce post-harvest losses in poor nations. Grainpro bags are inexpensive, multilayer polyethylene hermetic bags that efficiently preserve grains by keeping moisture and air from entering, hence avoiding insect infestation and the development of aflatoxin. PICS bags, constructed from HDPE and woven polypropylene liners, create an environment inhibiting insect development, offering a chemical-free alternative. Metal silos, made of galvanized iron sheets and hermetically sealed, provide robust protection against insects and rodents. The article highlights the effectiveness of these methods in reducing post-harvest losses, which can reach 20-30% using traditional storage. While all three methods offer advantages, the choice depends on factors like budget, grain type, quantity, and pest prevalence. The article emphasizes the importance of these improved techniques in enhancing food security, particularly in regions heavily reliant on grain production. Further research is needed to address concerns about pest resistance to certain storage methods.

13. THE ROLE OF GRAIN STORAGE SYSTEMS IN FOOD SAFETY, FOOD SECURITY AND RURAL DEVELOPMENT IN NORTH CENTRAL NIGERIA By Ugbede Victor Ahiaba

Summary:

In Kogi State, Nigeria, this study examined the function of grain storage systems in rural development, food security, and food safety. Using a mixed-methods approach that included stakeholder interviews, surveys, and on-site observations, it was discovered that poor storage structures resulted in contamination from dangerous pesticides and large post-harvest losses (20–70%). The study found that only 1% of farmers earned above the 2017 poverty benchmark, largely due to exploitative middlemen and limited market access. Current practices fell short of GlobalG.A.P. And BRC Global Food Safety standards. A proposed "Communal Model" addresses these challenges by establishing community processing and storage centers, providing training on Good Agricultural Practices, and facilitating direct market access through a digital platform. This model aims to improve food safety, reduce waste, enhance food security, and significantly increase farmers' incomes by bypassing middlemen and meeting international quality standards. The model also incorporates virtual farming for credit access and promotes sustainable practices.

14. Systems of Farm-level Storage of Food Grains and Use of Ferro cement for making Silos: A Review Chetan S. Deshpande1, Dr. Narendra V. Deshpande2

Summary:

This research paper reviews existing literature on farm-level food grain storage in India and the potential of Ferro cement for constructing silos. It examines various traditional and modern storage methods, highlighting their advantages and disadvantages, and emphasizes the need for cost-effective, durable solutions to reduce post-harvest losses. The paper then delves into the mechanical properties of Ferro cement, citing numerous studies on its strength, durability, and suitability for various structural applications, including jacketing and reinforcement. Finally, it explores the pressure computations and design considerations for silos, referencing relevant codes and standards (I.S. 4995 and EN 1991) and comparing theoretical and experimental findings on pressure distribution in silos.

15. Using Improved Storage Technology to Reduce Food Insecurity and Postharvest Losses in India Pallavi Shukla, Kathy Baylis and Hemant Pullabhotla1 June 2019

Summary:

This study examines how food security among Indian smallholder farmers is affected by enhanced on-farm storage technologies, particularly hermetic storage bags.
A randomized controlled trial demonstrated that access to these bags significantly increased storage duration (by 25%), the quantity of grain stored (by nearly 20%), and the proportion sold later at higher prices (by 30%). Farmers shifted consumption from market sources to their own stored grain (a 26% increase from own stocks, a 7% decrease from market sources), reducing reliance on market purchases during lean seasons. Aflatoxin contamination decreased dramatically (by almost 75%), improving food safety and potentially opening access to higher-value markets. Cost-benefit analysis revealed that farmers recoup the full unsubsidized cost of the bags within a single agricultural season, highlighting the economic viability of this intervention. The findings suggest that policy support for hermetic storage technology, including subsidies and information campaigns, could be a cost-effective strategy to enhance food security and reduce postharvest losses in India and similar contexts.

16. Storage Silos – Types & Advantages [PDF] – theconstructor.org

Summary:

Storage silos are structures used to store bulk materials like cement, grains, coal, and chemicals. They are typically cylindrical and constructed of steel or concrete, categorized by material stored (cement, grain, coal), construction material (steel, concrete), and discharge method (gravity, fluidization). Advantages include efficient storage, protection from the elements, and ease of

automated handling, contributing to cost-effectiveness in industries requiring large-scale material storage.

17. Bangladesh famine of 1974 - Wikipedia

Summary:

The **Bangladesh famine of 1974** was a catastrophic food crisis caused by severe monsoon floods that destroyed rice crops, exacerbating post-1971 war economic instability, government mismanagement, hyperinflation, and global food price surges. Estimates of deaths range from 27,000 to 1.5 million, primarily affecting rural laborers and the poor. The famine exposed systemic vulnerabilities, leading to political turmoil—including the 1975 coup—and prompting long-term reforms in agriculture, disaster management, and food security policies in Bangladesh.

18. Benefits of Silo's versus Warehouse

Summary:

"The Benefits of Silos Versus a Warehouse" by Christian L. Berger compares siloed data systems—where departments manage isolated datasets for speed, specialization, and security—with centralized data warehouses, which enable unified analytics, efficiency, and scalability by consolidating data across an organization. While silos offer agility and tailored solutions for specific teams, warehouses provide comprehensive insights and reduce redundancy. Berger suggests a hybrid approach, leveraging silos for operational flexibility while integrating critical data into a warehouse for strategic decision-making, balancing the strengths of both models based on organizational needs.

19. Advantages of Storage Silos. Structure and Characteristics of Silos | by storagetanks | Medium

Summary:

"Advantages of Storage Silos" by Allen discusses the benefits of using isolated data storage systems (silos) over centralized alternatives like data warehouses or lakes. It highlights how silos allow departments to maintain control over their data, ensuring faster access, tailored optimizations, and enhanced security by restricting sensitive information to relevant teams. The article also notes that silos reduce complexity for individual teams by avoiding dependencies on a unified system, though it acknowledges potential challenges in data integration and organization-wide analytics. Overall, silos are presented as a practical solution for teams needing autonomy and efficiency in their data management.

20. Silo Storage: Optimizing Cost and Efficiency in Materials Management

Summary:

The article discusses how silo storage systems optimize cost and efficiency in bulk material management by providing space-saving, automated solutions that reduce labor, minimize waste, and enhance inventory control. It highlights the benefits of silos, such as protection against environmental factors, improved material flow, and integration with advanced monitoring technologies, making them ideal for industries like agriculture, construction, and manufacturing. Proper silo design and maintenance further ensure long-term operational efficiency and cost savings.

21. Storage Silos Systems: Uses and Applications in Various Industries - Business | TWB

Summary:

Storage silos are covered in the article on The World Beast along with its systems, applications, and usage in a variety of sectors. Silos are essential for storing bulk materials like grains, cement, coal, and chemicals, ensuring safe and efficient storage while protecting contents from environmental factors. Different industries—agriculture, construction, energy, and manufacturing—rely on silos tailored to their specific needs, such as steel, concrete, or flexible designs. Modern silos often incorporate advanced technologies for monitoring, automation, and climate control to optimize storage conditions. The article highlights how silos improve logistics, reduce waste, and enhance productivity in industrial operations.

22. Frontiers | Editorial: Food storage, spoilage and shelf life: Recent developments and insights

Summary:

The essay examines how urban agriculture (UA) may improve cities' resilience, sustainability, and food security, especially in light of climate change and growing urbanization. It demonstrates how UA—including rooftop gardens, community farms, and vertical farming—can reduce food miles, improve local food access, and promote circular economies by recycling organic waste. The study also discusses policy and infrastructural challenges, such as land availability and water use, while advocating for integrated urban planning to support UA. By analyzing case studies and existing literature, the authors argue that scaling up urban agriculture requires multi-stakeholder collaboration, technological innovation, and supportive governance frameworks to maximize its socioeconomic and environmental benefits.

23. The impact of metal silos on rice storage and storage losses in China | Food Security

Summary:

In order to ensure China's national food security, it has lately become crucial to reduce food loss and waste. Given the significance of storing household grains, the Chinese government launched the Scientific Grain Storage Project (SGSP) to incentivize farmers to install cutting-edge storage facilities, primarily metal silos for rice storage. Using survey data from 1159 households across 21 provinces, we first examined the factors influencing farmers' adoption of metal silos before evaluating the effect of metal silos on storage losses and household rice storage using the Propensity Score Matching approach. The number of years of education, the size of the family, the annual net income, the cooperative membership, the planting area, and the religious beliefs of the household decision makers, and household decisions about the deployment of metal silos were substantially connected with knowledge of grain-saving techniques. In addition to reducing rice storage losses by 43%, from 1.6% to 0.7% of production, and protecting rice from rodent damage during storage, metal silos dramatically increased the amount of time that households stored rice by 18 days. Encouraging farmers to use metal silos is crucial to guaranteeing China's food security. By using metal silos, it is possible to meet the annual food consumption demands of 1.39 million people, increase the supply of rice by 626,800 t, preserve 86,600 ha of land, 29,400 t of fertilizer, and 0.82 billion m3 of water, and cut carbon emissions by 232,200 t. The SGSP program should be maintained, and farmers should be encouraged to use modern storage facilities

24. Concrete and Steel Storage Silos | Raven American Tanks

Summary:

The study evaluated the effect of metal silos on the storage of rice in households and discovered that their adoption was highly influenced by criteria such as awareness, income, and education. Metal silos decreased losses by 43% (from 1.6% to 0.7% of production), increased storage time by 18 days, and kept rodents away from rice.
. Widespread adoption could boost China's food security by increasing annual rice supply by 626,800 tons, saving land, fertilizer, and water, reducing carbon emissions by 232,200 tons, and feeding 1.39 million people yearly. The government is urged to promote these silos through continued support schemes.

25. Strengthening storage, credit, and food security linkages The role and potential impact of warehouse receipt systems in Malawi Brent Edelman, Lim Hak Lee, Athur Mabiso, and Karl Pauw

Summary:

With an emphasis on increased income and food security through effective markets, less post-harvest losses, and improved loan availability, the study looks at the possible advantages of Warehouse Receipt Systems (WRS) for smallholder farmers in Malawi. WRS could help net-consuming consumers by reducing price seasonality caused by narrow marketplaces and high transportation costs. However, unpredictable government interventions hinder price predictability, reducing WRS effectiveness. Post-harvest losses, estimated at 5–15%, could be minimized through WRS, though costs and transport barriers may outweigh benefits for some farmers. Access to formal credit, currently available to only 2% of farmers, is a key advantage of WRS, helping households avoids distress sales. Barriers to WRS adoption include high minimum deposit requirements, transport costs, lack of trust, and complexity. The study suggests piloting interventions like subsidized transport or simplified credit models to encourage uptake. While WRS holds promise for market efficiency and food security, its success depends on addressing adoption barriers and ensuring predictable market policies. Further research is recommended to refine cost-benefit analyses and explore alternative models like warrantee schemes, which may better suit smallholders. Overall, WRS could enhance food security but requires tailored solutions to overcome implementation challenges.