WATER FROM AIR: REVIEW AND PRACTICE

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ABSTRACT

The global lack of potable fresh water is becoming more apparent day after day. Although water surrounds the majority of the earth, usable water is insignificant. One explanation for this might be that 97% of the world's water is salt water, in addition to population growth, industrialization, urbanization, poor water resource management, and the fact that humans have contaminated most natural water supplies. To address this issue, air water harvesting might be one of the sources of potable water across the world, particularly in arid regions. In this research, it is reported on the water collection performance of numerous fog and dew collectors from across the globe. It would also discuss the technical aspects and efficiency improvements for fog and dew collectors. Summarizing the analysis of all available air water harvesting techniques, comparing their outcomes, and trying to decide which approach can extract water from air most efficiently and affordably. Therefore, the purpose of this review is to discuss the technical and engineering elements of all techniques of air-water harvesting, as well as identify available technologies, research gaps, and perspectives, so that this study will be useful in future advanced research. The benefits and limitations of air water harvesting as well as the procedures for air water harvesting using materials found around us, such as stone chips, brick chips, sand, leaves, grasses, and so on are discussed. In addition, it would go over how to generate dew water using a cooling condenser, a desiccant system, and condensation technology, highlighting the method's limitations and technical specifications. The results show: (i) A variety of materials namely Polythene Sheet, Cement Bag, Paper, Rod bar, Coarse sand, Fine sand, Brick Chips, Jhama Brick Chips, White and Black Stone, Dust Scutch Grass, Leaves, Hogla, and Long Grass are contributed to generate water at different rate from atmosphere fog under similar environmental condition; (ii) The maximum water output in the significance test was 819 ml/m^2 when a native plant leaves were utilized. The second production rate of 600 to 700 ml/m^2 is found for different sandy soils; and (iii) According to the literature review and the initial experiments, this process is found successful in light of water production from a nonconventional source. The limited production of water from air during dry season may cut-down the water storage capacity for rain water harvesting systems. That is this process can replenish the rain water demand in the problematic area.

Keywords: *air water, arid region, dew point, fog water harvesting, dew water harvesting, desiccant*

1. INTRODUCTION

Fresh water demand has become one of the world's biggest concerns as a result of population increase, climate change, natural catastrophes such as droughts and floods, and excessive usage. Human existence is threatened by this global issue of freshwater shortages, especially for those who reside in arid regions (Mekonnen & Hoekstra, 2016; Johnson, 2001). Although most of the water on our planet is plentiful but unusable, it requires a significant amount of external energy and time to make it usable, which is far more expensive than the usable water is generated (Singh et al., 2017; Morciano et al., 2020). Currently, over half of the world's population faces acute water scarcity for at least part of the year, and nearly two billion people lack access to safe drinking water. Climate change and population growth are expected to exacerbate these numbers (SDG Report 2022). Nearly 4,000 people perish from diseases brought on by inadequate WASH every day, with children under the age of five accounting for nearly 1,000 of these deaths (UNICEF, 2023). Water scarcity is certainly an issue that must be addressed promptly. The Earth's surface today has 3.0% accessible fresh water, with 97% of the water being salty. This clear water nevertheless includes a significant amount of ice (68.7%). This is true, especially in the Arctic and Antarctic. Only 0.26% (rivers and freshwater lakes) of the world's total water reserves (90,000 km^3) are used for human use (B. Kalidasan et al., 2021) Studies on potentially exploitable freshwater resources have been carried out recently. In order to use saltwater or wastewater, a variety of water purification methods have been developed, such as filtration, reverse osmosis, multistage flash distillation, and solar water purification (Jiao et al., 2020). Be that as it may, these innovations are as they were doable in coastal areas and are as often as possible blocked off in inland places due to their reliance on normal water supplies (Tu et al., 2018; Kalmutzki et al., 2018).

There are several techniques for generating potable water across the world, including desalination, groundwater harvesting, and rainfall collecting. However, for all of these techniques of water storage, it must have existing water from which it may collect and deliver useful water using the methods described above. All of these water storage solutions are not practicable if there is no existing water storage. One solution to this problem is air water harvesting, which allows us to readily gather water from the atmosphere. As a result, the technology of collecting water from the atmosphere is becoming increasingly popular across the world, and several sophisticated research studies are being conducted on the subject. A thorough assessment of the research on water harvesting from the air has been completed. This study will discuss the research works, the methods of creating water from the atmosphere, and the amount of water produced, as well as their thorough theory and the results of tests with some of the materials around us. Additionally, it will be demonstrated that the energy that is needed to create water from the atmosphere is minuscule in comparison to the amount of water that results. A number of commercially accessible mechanical items have been designed to produce water from the atmosphere; this article will explore their ways of functioning and act as a springboard for future, more in-depth studies on this subject (Jarimi et al., 2020).

A scarcity of usable water is a concern shared by all countries with adequate supplies of water and by those that are unlikely to experience a drought or lack of precipitation in the near future (Burek et al., 2016). Because the majority of the water in those countries is utilized for power generation, due to rising populations and climate change, among other considerations, they may be forced to use their stored water for drinking or power generation in the near future (Faeth et al., 2014). By 2050, over half of the world's population is predicted to experience a scarcity of drinkable water due to factors like urbanization, economic expansion, unsustainable resource usage, climate change, and excessive water use (UN World Water Development Report 2020, 2020). According to the World Resources Institute (WRI), a number of developed and developing countries have already become the top-ranked countries in terms of water stress. It is imperative that the scientific community find alternative and sustainable water-generating technology quickly in order to alleviate the current water scarcity. It has been predicted that the best approach to addressing this problem would be air water collection (Maddocks et al., 2015; Raveesh et al., 2021)

The environment surrounding us contains a lot of water vapor, which is why experts think that producing water from the air might be one of the solutions to future water shortages (Wang et al., 2022). There are several methods for extracting water from the atmosphere, including fog water harvesting, dew water harvesting, and absorption and sorption methods. Dew water harvesting is a method of producing water by reducing the temperature of ambient air's water vapor below the dew point, allowing the water vapor to condense into water. This technique of producing water from air generates more water than all other methods combined. It is generally carried out by employing a radiative cooling surface, a solar regenerated desiccant system, and active condensation technology. However, because this process requires external energy to generate water, the cost of production is frequently higher than the cost of water produced, which is one of the method's hurdles. Some plants and animals in dry regions spontaneously create dew water for their own consumption. Their water harvesting from air technology may also be utilized to create air water organically (Kabeel et al., 2004). In conclusion, this study will assist readers in learning about the technology utilized to produce water from air as well as the most efficient and economical method of doing so. Additionally, it will aid the researcher's progress in airborne water extraction for desert zones and other regions.

2. METHODOLOGY

The primary goal of this research is to generate useable water from water vapor in the air utilizing various materials and methods. A review of many publications on atmospheric water harvesting is presented, followed by a detailed explanation of how to do it with the resources that are readily available to us. Figure 1 depicts a flowchart showing how many ways water may be extracted from the atmosphere (Jarimi et al., 2020).

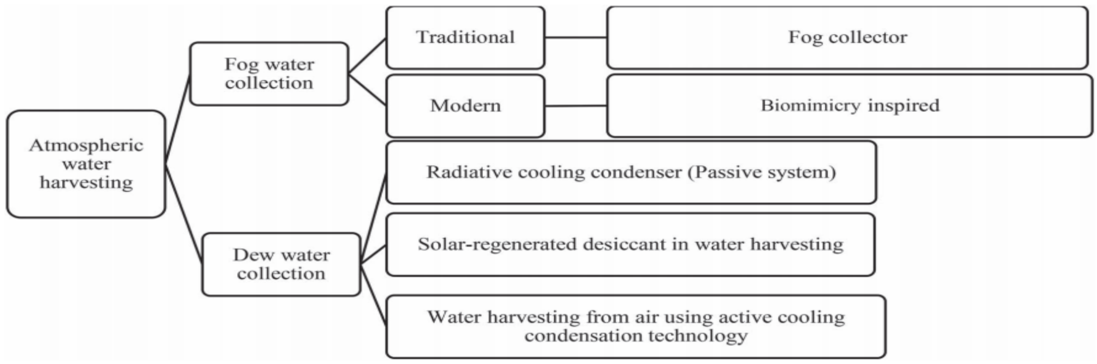

Figure 1: Methods of atmospheric water harvesting technics (Jarimi et al., 2020)

2.1 Review of Water Harvesting from Air

The atmosphere is always a massive store of useable water, containing roughly 1.29×10^{13} m^3 of water, from which a lot of water may be collected every day (Schneider et al., 2011; Graham et al., 2010). The process of generating water from the atmosphere is to transform the existing water vapor in the atmosphere into water; typically, the reverse cycle method, which is gaining popularity, is used to generate water from the atmosphere. One of the reasons for its popularity might be a scarcity of useable drinking water, and the process of harvesting water from the atmosphere is a recyclable process, i.e. hydrological cycle, water vapor is continually returned to the atmosphere, resulting in no environmental impact (Ahrestani et al., 2023).

2.1.1 Fog Water Harvesting

The approach of collecting fog water is straightforward, economical, and environmentally friendly. It includes employing a fog-catching net or mesh against a damp surface usually set in an inclined arrangement to capture water from the air. The usefulness of this technique is limited by the fact that fog occurrences do not occur everywhere. Nonetheless, given their advantageous geographic location and climatic circumstances, several countries have effectively implemented and shown this technology. Fog collectors generally provide water output ranging from 1.5 to 12 L/m^2/day in regions with year-round fog presence. In comparison, during a two-month favourable fog season, a research study in Oman recorded a relatively high discharge rate of 30 L/m^2/day. As a result, fog water harvesting is a seasonal occurrence. Its efficiency is determined by the type of fog-collecting device used, the amount of water in the fog, wind speed, terrain, elevation, and other variables. The influence of fog harvesting, mesh structure, bio-inspired patterns, design considerations, and climatic conditions is currently being investigated (Raveesh et al., 2021).

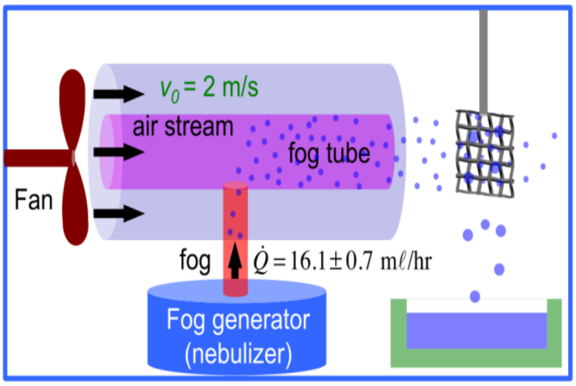

Figure 2: Generation of fog and water from air (Park et al., 2013)

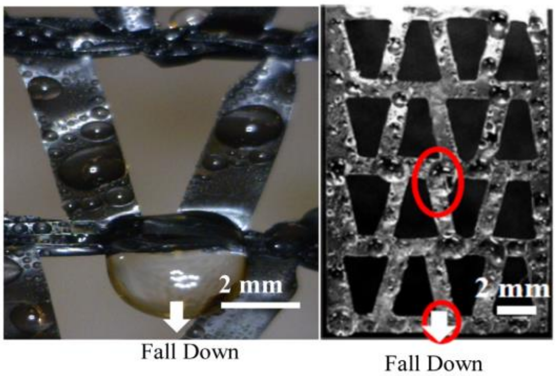

Figure 4: Different geometrical shape of raschel mesh (Rajaram et al., 2016)

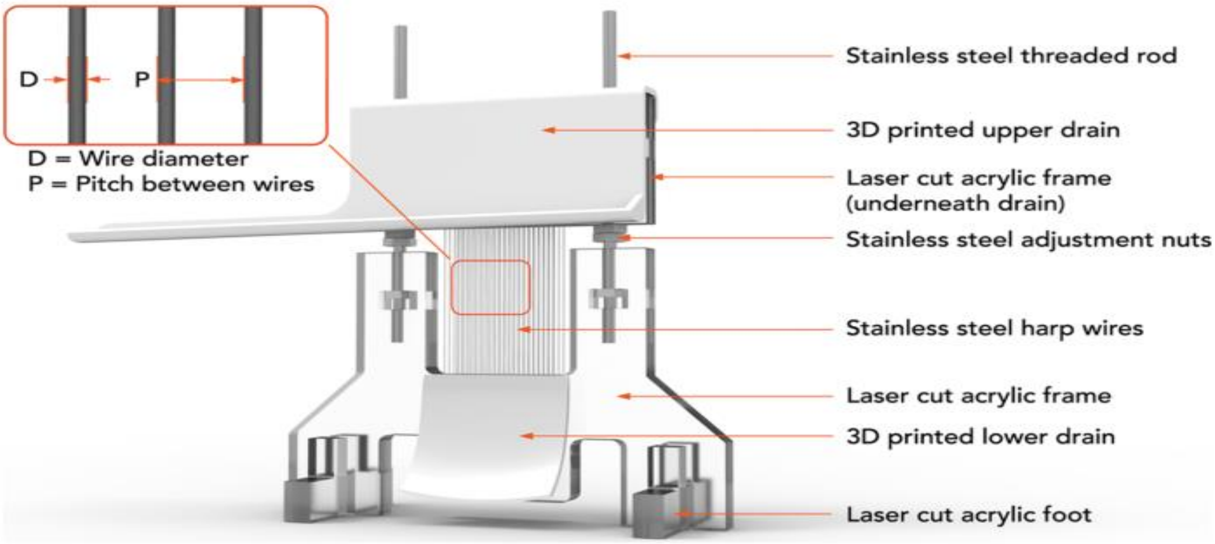

Figure 3: Technic of producing water from fog (Shi et al., 2018)

Kyoo-Chul Park and Shreerang S. Chhhatre (Park et al., 2013) revealed a revolutionary way of producing water by generating fog from water vapor. At a specific temperature, atmospheric water vapours are turned into fog, which is subsequently converted to water via wire mesh, which absorbs water from the fog. To improve the quantity of water absorbed from the fog, the wire mesh dia and internal gaps have been lowered. By transforming water vapor in the atmosphere to fog, the relative humidity is set to 100% and the temperature is set to 26.4+0.5. The volume of water created by fog to wire mesh has been raised around 5 times using this way. Figure 2 depicts how water is created by generating fog from water vapor and the generation of water by wire mesh. Weiwei Shi and Mark J. Anderson (Shi et al., 2018) used vertical wires called fog harps to collect. Water is generated from the fog with the help of a fog harvester through this wire meshes while maintaining the relative humidity at 100% at room temperature. This produced three times the water from raschel mesh of varying diameters and structures. Figure 3 illustrates depicts the technique of producing water from fog.

Jonggu Lee and Jinyoung So (Lee et al., 2020) demonstrated a method of generating water from fog through the construction of a fog collector with nanochannels and macrostripes. When the relative humidity is 65%, this approach may gather approximately 50% more water than traditional fog collectors. In other approaches, fog collectors quickly catch water and their interior pores are clogged, causing the fog collectors to be unable to store much water. However, due to the design, the absorbed water drains readily, and the holes in the wire mesh become empty, allowing the water to absorb again. As the process continues in this manner, the water production in this approach far exceeds that of all other ways.

Joanna Knapczyk-Korczak and Piotr K. Szewczyk (Knapczyk-Korczak et al., 2020), Showed that raschel mesh generated water from the fog through the combination of hydrophilic nanofibers. In the majority of situations, raschel mesh is employed in the production of water from the fog; in this approach, electrospun polyamide 6 is used as nanofiber with raschel mesh, resulting in three times higher water production from fog than all other methods combined. Mithun Rajaram and Xin Heng (Rajaram et al., 2016) used a Raschel mesh modification to generate fog water. It was found that by testing the surface of a basic raschel mesh with a highly hydrophobic coating and geometrical adjustments, it could generate twice as much water from the fog as the typical method. Figure 4 illustrates water collected in different geometrical shapes of raschel mesh.

Diago Crizat and Carlos Jerez-Hanckes (Cruzat et al., 2018) showed electrostatic water generation from fog. They generate the water from the fog in this way by producing a radial electric field between two electrodes. It is projected that it will produce 60% more water than all other traditional technologies combined. In Morocco, a monumental fog-harvesting structure, adorned with dense fog nets, graces a central expanse of 600 m². Over the last six years, this ethereal masterpiece has bestowed upon its surroundings the gift of 17 gallons of safe drinking water per square meter. Meanwhile, the Warka Tower, an architectural marvel woven from bamboo and polyester nets, stands tall at 10 meters, broadening its embrace over 4 meters. Each day, it weaves a daily symphony, producing 50 to 100 litters of liquid vitality drawn from the veiled dance of fog (Ahrestani et al., 2023). Fog harvesters were invented by Choiniere-Shields as a revolutionary way of collecting fog that could readily condense the fog into water. Because stainless steel condenses water more easily than other materials, it is employed in this approach instead of polypropylene mesh. One liter of water per hour may be produced by a steel mesh of 10 square feet (V et al., 2023).

Additionally, Fog Water Harvesting uses technologies inspired by biomimicry to analyse and investigate a variety of unique traits seen in animals and diverse tribes. The Namib Desert Beetles such as *Stenocara gracilips*, lispecies such as *Moloch horridus*, is among them; they are prominent examples of an animal that lives in an arid location. Regarding the plant world, there are native grasses found in the Namib Desert, such as *Stipagrostis sablicola*, as well as cactus, *Lychnis ieboldii*, and *Syntrichia caninevis*. All of these animals and plants are able to live not just in arid places but also in the process of gathering water from the atmosphere and fog (Jarimi et al., 2020). Only when there is sufficient fog in the atmosphere can fog water be collected. The primary obstacle to fog water collecting is the fact that fog varies greatly between countries due to differences in geography and material properties. It also cannot expect year-round water gathering from here because fog is a seasonal occurrence.

2.1.2 Dew Water Harvesting

Dew water harvesting is the process of lowering the temperature of the surrounding atmosphere's water vapor below the dew point, which causes the water vapor to condense into liquid. Dew water harvesting may be accomplished by a variety of active and passive techniques, such as water vapor concentration using sorption techniques, solar-generated desiccant, cooling condensers, and active refrigeration. A new hollow-shaped structure is being built to collect dew water. The major goal was to expand the surface area without increasing the height or breadth so that it could contain more water. They employed an inclined planar condenser, which is inclined at 30 degrees from the plain surface, for this. This experiment revealed that the hollow-shaped structure can absorb more water than the planer form (Beyssens et al., 2013).

Dew water collecting mostly uses smooth, non-grooved surfaces. Royon L. and P.B. Bintein (Royon et al., 2016) collected dew water on micro-grooved surfaces rather than smooth non-grooved substrates. The process is handled by maintaining relative humidity, substrate inclination with horizontal, and groove location, which shows that a micro-grooved surface produced nearly twice as much water as a smooth non-grooved surface. It has been demonstrated that using patterned polymer covering with a condenser pipe while maintaining a given temperature and humidity produces around 57% more water than an uncoated plain surface (Al-Khayat., 2017).

When it comes to water production from the atmosphere, it frequently overlooks the passive water harvesting zone. Barbara Ting Wei Ang and Jiong Zhang (Ang et al., 2019) used the cascade effect in the active and passive harvesting regions in the instance of water production from the atmosphere at 90% relative humidity and showed that water production increased almost thrice when compared to the unmodified scenario. Ming Zhou and Haomin Song (Zhou et al., 2019) demonstrated that collecting dew water with a daytime radiative cooling condenser at 100% relative humidity and 25 degrees Celsius boosted the water generation rate from roughly 0.4 L/m^2 to 1.5 L/m^2/day. In addition, dew water has been obtained from the atmosphere very readily by utilizing the decoupling of the radiative emitter and dew collector (Zamir et al., 2019), Extending dew harvesting to loss humid areas (Dong et al., 2020), and the feasibility of a dew collecting plant (Sharan et al., 2017).

Active condensers, or atmospheric moisture generators, are different from traditional techniques. With a compressor power of 1000 watts and an average airflow of 400 cubic meters per hour, the unique air water generation generates water at a minimum temperature of 10°C while also bringing the surrounding air temperature down by 8°C below the dew point. This invention has two independent 2-litre water reservoirs that may be programmed to produce water on different times for each container. The equipment has the following measurements: height of 35 cm, length of 25 cm, and width of 14 cm (Cattani et al., 2021). India's first large-scale potable water production plant was opened at Kothara village, Kutch district. It is designed to collect atmospheric moisture and turn it into drinking water. Planar panels with high emissivity plastic film insulation underneath the condensers provide effective cooling. These condensers are skilled in collecting rainwater in addition to dew water. According to reports, the facility is expected to produce 150,000 litres of treated, filtered potable water yearly, with each litre expected to cost 0.5 rupees (Sharma et al., 2017).

2.2 Practice of Water Harvesting from Air

The primary goal of this investigation is to find several viable water-absorbing materials for water harvesting from air. Initially, materials and plants were taken from the KUET extension area located in Khulna, Bangladesh; the samples were obtained early in the morning, and the minimum temperature was 19 degrees Celsius during the first collection of the samples. The majority of the site was drenched with fog water, which is why the samples in our collection were saturated with fog water. The samples were collected, brought to the lab, and divided into two groups, including natural materials such as sylhet sand, kustia sand, white stone, black stone, leaves, scutch grass, hogla, and dust. And synthetic materials like brick chips, jhama brick chips, rods, cement bags paper, polythene sheets, etc. The sands were carefully placed on the tray before the initial measurement, and the remainder of the materials were gathered in polythene bags. After determining the initial weight of all the components, they were set to dry in the sun on the large rectangular glass shown in Figure 4. The stone and brick chips are separated from the other materials and placed on a glass tray with tissue below to keep the absorbed water from rolling off the top.

To ensure that the fog water that was collected did not fall from the samples, great care was used when gathering the samples. Additionally, to stop the water within the samples from evaporating, they were collected in polybags and secured with rubber bands. The amount of water that evaporates is regarded as water generation that this substance has drawn from the atmosphere.

Figure 5: Collected sample materials

Figure 6: Fog water absorbing materials

Figure 7: Mesurement of sample materials

The process of drying and storing the samples to gather the fog water for the next day is depicted in Figure 5. Figure 6, and Figure 7 illustrate how the samples store water and how their area was measured, respectively. After the samples had sufficiently dried, they were put back into the polybags, and their final weight was determined. Afterward, the weight of the water has been removed by deducting the final weight from the initial weight; this allows us to calculate the amount of water that the materials contained from the fog. In this method, data spanning four to five days has been used to examine the amount of water those materials can store from the atmosphere.

3. RESULT AND DISCUSSION

During this particular season, the location where the samples were taken is often foggy between 10 p.m. to 4 a.m. The level of fog changes every day depending on the weather. When there is a lot of fog in the air, the saturation vapor pressure is higher than on days when there doesn't appear to be a considerable fog. According to the weather report, the wind speed is quite high on days when the fog is high, and the wind speed is a bit higher in the afternoon and morning, decreasing quicker during the night. The temperature fluctuated from a low of 15 degrees at night to a maximum of 30 degrees throughout the collection and testing of the samples. During periods of heavy fog, temperatures decrease fast. An investigation of the days with dense fog at night revealed a minimum temperature of 15°C rising to a maximum temperature of 30°C during the day. Table 2 illustrates the highest and lowest temperatures, relative humidity, meteorological conditions, and dew points for each test day.

In this study, 14 to 15 different types of materials were evaluated, each with significant variances in their mutual nature. There are generally stone-type materials, sand-type materials, and plant-type materials with varying water-holding capabilities. Furthermore, the water resistance of the materials varies depending on the weather. Table 1 illustrates how much water each substance may generate from air on its own during day-1 to day-6 dated 28 November 2023 to 23 December 2023. According to the available data, tiny tree leaves have a far higher water-holding capacity than any other materials, at 819 ml/m^2, whereas white stone has the lowest, at 60 ml/m^2.

The amount of water generated on day-1 for Scutch Grass, Leaves, Hogla, Long grass, and the rod is 467,819,91,191 & 559 ml/m^2 respectively and the amount of water produced on day-2 is 165,233,36,73 & 590 ml/m^2 respectively, which is equivalent to significantly less than day-1. It examined the weather conditions on day-1 and day-2 and found that day-1 was sunny and day-2 was gloomy, resulting in substantially less fog on the second day than on the first. That’s why materials absorbed less water from the atmosphere than the previous day, resulting in less water generated than the first day.

Table 1: Amount of water generated by sample materials (28.11.23-23.12.23)

Sample Name	**Amount of Water (ml/m^2)**					
	Day-1	**Day-2**	**Day-3**	**Day-4**	**Day-5**	**Day-6**
Scutch Grass	467	165	-	-	-	-
Leaves	819	233	-	-	-	-
Hogla	91	36	-	-	-	-
Long Grass	191	73	-	-	-	-
Cement Bag Paper	203	-	89	79	91	91
Rod Water	559	590	-	-	-	-
Polythene Sheet	146	-	150	108	101	94
Kustia Sand	514	207	601	539	663	352
Sylhet sand (High FM)	526	207	663	477	580	373
Sylhet Sand (Low FM)	528	186	414	373	311	497
Brick Chips	425	155	419	419	496	357
Jhama Brick Chips	273	109	341	310	357	295
White Stone	60	78	202	155	124	109
Black Stone	282	202	264	217	295	357
Dust	-	1741	725	414	373	456

Reviewing the findings of Black Stone, White Stone, Jhama Brick chips, and Brick chips from day-1 to day-6 reveals that the quantity of water generated on day-1 is significantly greater than on day-2 because the amount of fog on the first day was much higher than the day following. Reviewing the results from the third, fourth, and fifth days, it is clear that brick chips can produce more water than all other types of stones, and that the water production capacity of the materials has increased as the amount of fog has increased based on their condition. By comparing the findings of Sylhet sand, Kustia sand, and dust from day-1 to day-6, it can be seen that the water holding capacity of Kustia sand is substantially larger, and the water production capacity has also grown with the increase in fog.

The water-holding capacity of all the materials examined is dependent on several factors, such as temperature, relative humidity, weather, and dew point. Furthermore, the amount of water provided by each substance is dependent on the way the water is collected from these materials. The scutch grass instance shows 467 ml/m^2 water generation from the air on day-1 and 165 ml/m^2 water generation from the air on day-2. Although the obtained sample area was the same, the difference in readings was due to the water-collecting technique. On the first day, grasses from the entire chosen region were evaluated, but on the second day, water was collected by absorbing water from an equivalent area through tissue paper. Similarly, in the case of leaves and rods, the water collecting method is the cause of such diversity in water generation outcomes. When the results of different types of sand are compared, it is clear that the volume of water generated on day-2 is significantly lower. By evaluating the weather conditions on day-2, it can be shown that the weather was cloudy, which resulted in less fog, and therefore the materials had less water than on earlier days. Finally, the examination of dust water generation showed that water generation on day-2 was more than double that of other days. Because the dust sample was significantly saturated on the day it was collected, the water production rate reduced significantly in the subsequent days, implying that the dust sample's genuine air-water generation capacity ranged between 414 ml/m^2 to 725 ml/m^2. Moreover, there are notable variations in the amount of air water generated through these materials on different days. When the values of the samples were obtained, the weather was sunny on the first day, overcast on the second, and cool and foggy on the third and fourth. As a result, there is a difference in values throughout the day. Table 3 illustrates the area of individual material which is used for testing purpose to generate the water from air.

Table 2: Weather parameters of sample taking days

		Day-1	Day-2	Day-3	Day-4	Day-5	Day-6
Temperatures	**Max**	29℃	30℃	26℃	26℃	26℃	27℃
	Min	19℃	20℃	16℃	15℃	15℃	17℃
Relative Humidity		59%	55%	54%	41%	48%	64%
Weather Condition		Sunny	Cloudy	Cold	Cold	Cold	Foggy
Due Point		14℃	14℃	9.7℃	5.1℃	7.8℃	13℃

Table 3: Area of tested materials

Name of Materials	Area (m^2)	Name of Materials	Area (m^2)
Scutch Grass	0.027/0.055	Sylhet sand (High FM)	0.048
Leaves	0.023/0.021	Sylhet Sand (Low FM)	0.048
Hogla	0.169/0.252	Brick Chips	0.065
Long Grass	0.058/0.327	Jhama Brick Chips	0.065
Cement Bag Paper	0.415	White Stone	0.065
Rod Water	0.041	Black Stone	0.065
Polythene Sheet	0.428	Dust	0.048
Kustia Sand	0.048		

4. SIGNIFICANCE WITH LIMITATIONS AND FUTURE WORK

In order to prevent future water contamination and provide clean drinking water, atmospheric water collecting is a viable, age-appropriate technique. Nevertheless, there are a number of drawbacks. One of these is that, in the case of fog harvesting, the fog does not fall uniformly throughout the world, or in those that do, there is a specific time frame for which this method cannot produce water all year round. The majority of dew water collection techniques rely on outside energy sources, which drives up the price of producing water. This is a constraint in the process of producing water from air using this technique. In this instance, a challenge for issue solving is whether future water shortage may be mitigated by the development of technology that can generate water from air in any climate in any location. In this instance, I'm optimistic that the aforementioned research projects may aid in the future discovery of new technology.

Even though there are countless water sources across the world, the scarcity of fresh, potable water is growing by the day. Water scarcity affects almost two billion people. There are several methods for creating potable water, such as desalination and filtration, however, these methods are both expensive and time-consuming. Water extraction from the atmosphere is reasonably simple and inexpensive, although it is still in its infancy. Fog water harvesting and dew water gathering are two ways to generate water from the atmosphere. Condensation technology is mostly employed in the collecting of dew water. Because this approach demands a lot of external energy, the water generated is not cost-effective. Moreover, it becomes highly expensive to use in dry places since the relative humidity in dry areas is quite low, resulting in a low dew temperature that takes a lot of energy to drop the air temperature below the dew point. In this situation, many natural materials may be utilized to collect fog water, which is far easier and less expensive than any other way. In terms of collecting fog water, the absorption approach is far superior. Water may be easily created from fog by employing materials with a hydrophilic exterior surface. The only issue in this scenario is that this strategy must be applied based on the weather conditions in every country. The maximum water output in the significance test was 819 ml/m^2 when plant leaves were utilized as desiccant materials in our research work. Furthermore, water may be generated from atmosphere fog utilizing a variety of materials such as sand, stone, and others. One benefit of this technology is that it does not require any external energy because it creates water naturally from the atmosphere fog. This technology can be applied to produce drinking water from contaminated source with salinity, arsenic, etc. using the cool and hot environments as prevail during the day and night (Rabbani & Bari 2021; Shafiquzzaman, et. al. 2022; Shafiquzzaman, et. al. 2023; Brojen et. al. 2023). This process can also be applied for effective wastewater treatment (Rahman et. al. 2011; Debnath et. al. 2019; Nayan et. al. 2021). This research will contribute to the body of knowledge on the generation of water from the air in arid regions as well as other places.

5. CONCLUSIONS

The following conclusions are drawn:

- A variety of materials namely Polythene Sheet, Cement Bag, Paper, Rod bars, Coarse sand, fine sand Brick Chips, Jhama Brick Chips, White & Black Stone, Dust Scutch Grass, Leaves, Hogla, and Long Grass are contributed to generate water at different rate from atmosphere fog under similar environmental condition.
- The maximum water output in the significance test was 819 ml/m^2 when native plant leaves were utilized. The second production rate of 600 to 700 ml/m^2 are found for different sandy soils.
- According to the literature review and the initial experiments, this process is found successful in light of water production from a nonconventional source. The limited production of water from air during dry season may cut-down the water storage capacity for rain water harvesting systems. That is this process can replenish the rain water demand in the problematic area.

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