A thorough literature survey should be conducted to discover those plants which supply the needed dietary complements and produce the greatest yield in the smallest volume occupied by the plants. Furthermore, these plants should be adopted to hydroponic growth under artificial light using processed waste material for a nutrient source. Other factors that should be taken into consideration are the temperature requirements during the period of photosynthesis as well as the respiratory period. Plants which have the same temperature requirements for optimum growth, flowering and fruiting are more to be desired than those of simular light requirements since the lighting requirements can more easily be met. Further selection of varieties of plants to be included in the hydroponicum will be based on resistance to disease and early maturity.

The technique of growing plants under artificial light has been utilized for many years. Data are available from many sources on a number of crop plants and should be consulted prior to actual

experimentation. It has been assumed that light be supplied by fluorescent tubes of the proper phosphors to simulate the spectrum of sunlight as closely as possible. The necessity of an infra-red source is indicated because this portion of the spectrum is required for water activation. In previous experiments reported in the literature this infra-red radiation was supplied by incandescent bulbs. Possibly these bulbs can be omitted through the aforementioned use of different phosphor coatings on fluorescent tubes. Problems of a mechanical nature, such as, spacing of the tubes, and control of heat created by the tubes would have to be solved through experimentation.

The use of sewage wastes for the growth of plants has been practiced in many different areas of the world, but, due to its lower nutrient value, has always been used as a soil supplement, never as the sole nutrient source. Preliminary experiments using sludge and effluent from the Martin Company Sewage Disposal Plant have shown that growth up to a certain point is possible without

the addition of any other fertilizers. These plants are growing in a Perlite medium which affords support for the plant roots and holds a certain amount of water, but does not contribute to the nutrient requirement of the plants. This material obtained from the sewage disposal plant consists of the residue from bacterial decomposition of human wastes and all garbage and table scraps from the cafeteria. The cafeteria waste is derived from the food preparation and resultant table scraps, ~~of one meal per day.~~ It must be pointed out, however, that much of the waste from the cafeteria consists of previously prepared foods, such as canned goods. This would not be comparable to the situation in the lunar house where all inedible plant and animal parts would be decomposed in the disposal unit and reutilized as plant nutrients. It must be determined how the composition of the waste material would be affected by the inclusion of these plant and animal parts, and the effect of a limited diet on the human waste material. Research in this direction must be carried out.

Since it is planned to use the unicellular green algae

Chlorella for photosynthetic gas exchange, this algae can supply the major source of food for the occupants of the lunar house. The food value of Chlorella has been determined and will supply more than the minimum requirements for all vitamins except vitamin C. Chlorella can be grown to contain more than 50% protein comparable to that of white flour, corn gluten or peanut meal. Since vitamin C is not present in sufficient amounts, this must be supplied from another source. Green leafy vegetables are particularly high in this vitamin, especially kale and parsley. A good source of additional carbohydrate might be rice; since it grows submerged in water this would probably simplify the growth in hydroponic tanks.

Mention of other food plants ??

The inclusion of animals as a food source has been seriously considered. Experiments on feeding animals with Chlorella are being conducted by cooperating research groups. Even if successful results are obtained a certain amount of roughage is necessary for the well-being of the animal. This applies to fowl as well as ruminants. A large area is necessary to grow enough forage material to feed small animals. Techniques have been devised to grow grass in tiers of

hydroponic trays thus utilizing space to a greater advantage. It may be concluded that animals would be included only if absolutely necessary since they are relatively inefficient converters of plant material and demand more attention than growing plants. However, this does not indicate that experiments with animals would not be undertaken. They supply an excellent protein source.

The production of protein through the use of tissue culture methods has been suggested. It would be necessary to determine whether solutions of organic materials derived from waste products would meet the growth requirements of these cultures. Apparently, growth is quite rapid under optimum conditions and a greater efficiency of conversion to protein is obtained. This animal protein is complete, i.e., it contains all the essential amino acids in adequate amounts.

Another efficient conversion of the waste material to edible protein might be in the growth of mushroom mycelium in aerated liquid culture. A product containing close to 50% protein, 3% fat and 8% mineral content can be obtained. In addition, this material

has the characteristic flavor of commercial mushrooms and may be used to enhance an otherwise bland diet. Some experimental results have been obtained on a few varieties of mushrooms, however, there are many edible species which might be more suitable for growth in the waste material available.

Chemicals which regulate the growth of plants have been in use for many years. These materials affect the plant in various ways. Various effects observed by their application are: stem elongation, termination of dormancy, earlier flowering and fruiting and higher yields under suboptimal growing conditions. Much pertinent information can be derived from various technical journals, but the specific effects which are held to be desirous in the hydroponicum would have to be investigated through a series of well-replicated and controlled experiments.

Several preliminary research problems which entail a multitude of experiments must be solved prior to occupying the Lunar Housing Simulator.

Lending to the space problem within the simulator, all containers, benches, and tanks must be kept to a minimum size, but still enabling

optimal plant growth. Of equal importance is the interchangeable standardization and versitility of all hydroponics benches.

Studies and tests will be made on materials of a lightweight, non-decomposable, and porous nature, that may be reused for the purpose of seed germination, propagating, and as an anchor for mature plants.

The entire hydroponic system will be so designed that humidity, temperature, lighting and plant feeding will be completely automatic.

In the laboratory and also in walk-in pressure chambers, studies will be made on the effects of reduced pressure (5 to 7 psi) on seed germination as well as growth rate and fruiting of several varieties of plants.

The chamber will also serve as a light chamber and will be equipped with fluorescent and incandescent light along with utilities required to control temperature, humidity and gases. Various experiments will be conducted on increased CO_2 and O_2 content, and will also be necessary to determine the time from seed to harvest, and the most time-saving methods for harvesting plants.

Studies will also be conducted on the composition and yields in comparison to field-grown plants.

Experiments will be necessary to determine to what extent the growth and efficiency of plants will be increased with the use of hormones and growth substances, such as Gibberellin, indoleacetic, indolebutyric acids, which are aids in stimulating and accelerating growth along with naphthaleneacetic acid to promote fruit setting.

Treatments to increase the availability of nutrients from processed waste will be perfected. Decreasing the particle size of the waste material for more efficient digestion and uniform distribution in the hydroponic benches is required.

Furthermore, to obtain the maximum nutrient value from the processed waste, it might be necessary to promote additional bacterial decomposition. After the available nutrients have been obtained by the plants, the spent waste will be incinerated to obtain the residual mineral salts.

After thorough testing of the component parts, such as the growth of plants in an artificial environment and waste utilization

experiments will be carried out in the lunar housing simulator. The effects of growing plants on the atmospheric composition will be studies. Operational studies will be made to minimize the man hours necessary for the production of food. Schedules will be formulated to enable the occupants to produce a constant supply of all necessary foods for their survival. Certain emergency conditions that would imperil the food supply would be simulated so that corrective measures could be applied. Incidence of possible plant disease, shifts in dietary formula and resultant changes in the composition of waste material, failures in various portions of the automatic mechanisms controlling the lighting, feeding and temperature of the food plants would call for immediate remedial measures. Undoubtedly there are many other studies which will necessarily be made but are now unforeseen.