UNIVERSITY OF IDAHO,

COLLEGE OF AGRICULTURE.

Idaho Agricultural Experimental Stations

BULLETIN NO. 3.

MARCH, 1893.

THE APPLICATION OF CHEMISTRY

TO THE

AGRICULTURAL DEVELOPMENT OF IDAHO.

These Bulletins are sent free to all residents of Idaho who request them.

MIRROR PRINT, MOSCOW, IDAHO.

UNIVERSITY OF IDAHO.

BOARD OF REGENTS.

HON. PHILIP TILLINGHAST, Pres.,	Moscow.
GEN. R. Z. JOHNSON, Vice-Pres.,	Boise City.
DR. W. W. WATKINS, Secretary,	Moscow.
HON. WILLIS SWEET,	Moscow.
J. F. AILSHIE,	Grangeville.
S. M. COFFIN,	Caldwell.
A. J. CROOK,	Clayton.
H. H. HOFF,	Montpelier,
DR. C. W. SHAFF,	Lewiston.

R. S. BROWNE, Treasurer.

COMMITTEE IN CHARGE.

Regents Tillinghast, Watkins and Coffin.

STATION COUNCIL.

President F. B. GAULT, M. S.,
Chairman.

Robert Milliken,	Director, Agriculturist.
J. E. Ostrander, A. M., C. E.,	Irrigation Engineer.
C. W. McCurdy, Sc. D.,	Chemist.
L. F. Henderson, Ph. B.,	Botanist.
....,	Entomologist.
....,	Meteorologist.

STATION STAFF.

John Norwood, Experimentalist,	Grangeville, Station No. 1.
W. F. Cash, "	Idaho Falls, Station No. 2.
T. P. Rutledge, "	Nampa, Station No. 3.

Central Station, University of Idaho, Moscow, Idaho.

THE APPLICATION OF CHEMISTRY TO THE AGRICULTURAL DEVELOPMENT OF IDAHO.

CHAS. W. McCURDY.

HISTORICAL SKETCH.

The principles of Chemistry are hoary with age. This is implied in the etymology of the term, "Chemia," of Egyptian origin, an art practiced by that once famous people.

Like all sciences which have found their basis in Nature, Chemistry has been one of slow growth, founded upon experiment. The ancients knew little of that phase of the science as the moderns understand it, hence were compelled to advance along the line of unintelligible theory; their ideas were purely speculative, unverified by experiment.

The science was known to the Egyptian priests as the Black Art. Still they advanced in the art of dyeing, glass working, painting and healing; and were skilled workmen in pottery and metallurgy.

Instead of the sixty-eight or more elements known to the chemist of this decade, the ancients, even Aristotle, knew but four primary substances—fire, air, water and earth. Later Geber, an Arabian Alchemist in the eighth century, declared that mercury, and sulfur and salt were the primary substances, all other metals being derived therefrom.

The great teachers of Spain, France and England during the Middle Ages, fostered the science, while Paracelsus in his search for the "Elixer Vitae" may be said to have founded the science of Medical Chemistry. Agricolla, who died in 1555 A. D., gave us the first work on metallurgy and mining; while "Alchemia," the first Hand-Book of Chemistry, dates back to 1595.

Thus early the science gave promise of a fruitful harvest, though it was left to Boyle to raise Chemistry to the dignity of a true science; Heretofore it had been clothed in superstition; now it was shorn of its sophistry and began to take its place as an agency of civilization.

In 1774, Priestly discovered oxygen, the supporter of life and combustion, followed shortly by Lavoissier's explanation of the same; then came Cavendish, who gave us hydrogen and promulgated the fixed composition of the air; Scheele, with his principles of "Quantitative Analysis;" Dalton, with his great laws of "Definite and Multiple Proportion" and the "Atomic Theory;" Gay Lussac, with laws of "Gaseous Combination;" Graham, with "Gaseous Diffusion;" Dulong and Petit, with "Specific Heat," Davy, with the "Electro Chemical Theory;" Avogadro, with "Size of Gaseous Molecules;" Leibig, with his principles of Agricultural Chemistry;" Kirkoff and Fraunhofer, with the spectroscope; Soliel and others with the polariscope, all of which have aided the science in its onward march and made it the hand maid of commerce.

APPLICATION.

From this vantage ground Chemistry forged rapidly ahead. Not only the qualitative but the quantitative composition of compounds could be determined absolutely. Some men gave their lives to advancing the science, pure and simple, for its own sake; others of practical mind recognized its utility and harnessed this potent factor in the interest of humanity as applied to the arts, in manufactures, in medicine and to agriculture.

Not only, therefore, is Chemistry found in the van of all sciences; but, founded upon the atom, it is the central pillar of all scientific knowledge, the fountain whence all streams of science diverge. It is no longer clothed in sack cloth and ashes fit only to be studied in secret places and at uncanny times. The modern High school without its chemical course, and the University without its thoroughly equipped laboratories are pointed at in derision, and well they may be; for no other science enters so largely into our daily life.

Chemistry has given us pure water and unadulterated foods and has taught us how to prepare them for the table; it has given us pure milk as against the chalk and water compound, and has taught us how to prepare the ensilage and care for the dairy that the product therefrom may be pure and wholesome; it has enabled us to know the composition of plants and their products, and what soil ingredients are necessary for their nutrition; it has given rise to commercial fertilizers and artificial manures, and determined their fertilizing value per ton; it has taught us how to plant and when to harvest our crops that the yield may be large and of good quality; it has discovered the grape rot and the means of preventing it; the remedy for the smut on wheat and oats and other blights of a serious nature; it has given us methods of exterminating the insects that prey upon our fruits, our grains, our stock, our homes; it has taught us how to get the gold from the rock and convert it into the sovereign; what is the best fuel to meet our needs and comfort; we owe to it our knowledge of valuable medicines and how to use them for the healing of the sick; how to prepare the most tempting beverages, and the most delicate perfumery. Thus much and more it has done. The border line of the organic principle has been crossed and many of our most valuable foods are now exclusively the product of the laboratory.

Such, briefly, is only a part of the mission of the science which is to come into close relation with every agriculturalist of our State until he shall feel that the department now established in our State University is essential to his highest happiness and success.

GEOLOGICAL FEATURES.

Idaho has an area of 84,290 square miles. The soil is volcanic, about equally divided among rolling plains, mountainous regions and lava beds.

The extent of arable land is indefinitely stated owing to the lack of proper surveys. But we are assured that the greater portion of the State will be brought entirely under cultivation for the growing of grain, grazing and horticultural purposes.

Southern Idaho is a great lava plain through which the Snake river has cut its way. Here the volcanic material is still *in situ* and comprises vast arid regions, but fertile in the extreme when irrigated. The eruptive material forms the surface soil. The Silurian formation outcrops prominently, overlaid in places by the Carboniferous and well defined areas of the Triassic, Cretaceous and Tertiary strata. The Quarternary areas are largely confined to the river bottoms constituting the arable lands, bounded by extensive grassy plains or sage brush areas. Such is the prevailing geological formation of the southern third of the State.

The Salmon river penetrates a mountainous region rich in mineral resources and timber and whose valleys offer every inducement to the husbandman; while the Clearwater flows placidly along through one of the best grazing districts in the northwest.

North of the Clearwater the soil is of alluvial formation, volcanic in origin, and requires no irrigation. It is a part of the great Palouse country, famous for its agricultural resources. The soil is deep, finely divided and extremely fertile. An extensive lake and river system adds to its desirability. Thus much is true of the greater portion of Nez Perce, Latah, Shoshone and Kootenai counties.

Indeed, the economic features of the State are most varied, from the plains of Lewiston (530 ft.), to the more elevated regions of Boise City (2490 ft.), Moscow (2569 ft.), Pocatello (4446 ft.), Idaho Falls (4712 ft.), Rathdrum, Murray and Hope, that only the hand of the trained scientific agriculturist aided by the practical irrigation engineer, is needed to make our beautiful "Gem of the Mountains" the most fruitful and wealthiest of the North-West States.

ALKALI SOILS.

The term alkali soils is applied to those lands which contain a large amount of soluble salts in their composition, usually sulfates of soda, potash, lime and magnesia. Such soils may be known by the peculiar incrustation which appears upon the surface in dry weather, after a season of rainfall or irrigation, or, by the taste. They are finely divided soils, very dusty when dry, and will absorb large quantities of water. They are largely the product of volcanic formation; are very generally distributed over the earth, but more especially noticeable in those regions where there is insufficient rainfall.

Nearly all soils contain alkali salts, but the frequent drenchings by rain or river flow wash the soluble salts deeply into the subsoil whence they will not again soon reach the surface, except by capillary action induced by surface evaporation.

The only sure remedy, therefore, would seem to be perfect underdrainage and deep tillage; surface flooding, in any form, without such treatment affords only temporary relief, as surface exposure will cause the alkali to rise.

Vegetation requires some of the salts named as sustenance, and they are detrimental to the plant only when present in too large quantities; in such cases the roots are corroded, the woody fibre poisoned and the plant is "set back" in consequence. When the subsoil is near the surface such is likely to be the case. Piercing the subsoil with a crow-bar will partially obviate the difficulty.

ALKALI SOILS OF THE NORTH-WEST STATES.

This question is of interest not only to the agriculturalists and scientists of Idaho, but has become an absorbing topic of discussion among farmers, stockmen and horticulturists in regions adjoining us. Dr. Hilgard of California has thoroughly investigated the subject, upwards of fifteen hundred (1500) analyses having been made by that Station of soils selected from California, Oregon, Washington and Montana; but, to my knowledge, no analytical study of Idaho soils has ever been undertaken.

COMPOSITION OF ALKALI.

The analyses made by the California Station show a composition of the soluble parts to consist, in the main, of potassium carbonate (saleratus), sodium sulfate (Glauber's salt), sodium nitrate (Chile saltpeter) potassium nitrate (saltpeter), sodium carbonate (sal soda), sodium chloride (common salt), calcium sulfate (gypsum), magnesium sulfate (Epsom salts), sodium phosphate, potassium sulfate, ammonium carbonate and organic matter composed largely of humus or vegetable mold. The ingredients predominating are Glauber's salt, common salt and sal soda in about the order named, though subject to considerable variation in the two types of aikali.

BLACK AND WHITE ALKALI.

A very superficial study of soils sent to this department for analysis reveals the fact that there are two well marked types of alkali, the "white" and "black." Chemical analysis and practical tests made in the field prove the black soil to be the worse. It is composed largely of soda carbonate with varying proportions of humus. When a watery solution of this type was evaporated slowly over a water bath, or by exposure in mud holes, a dark ring was left about the vessel and on the soil surface. This dark ring was found upon closer examination to be largely humus that had been held in solution.

Dr. Hilgard, whose wide observation and thorough study entitles him to speak with authority, writes concerning humus: "This in itself is serious injury, for humus is one of the most important of soil ingredients. If held in solution, or washed through the soil, the producing powers of the land are seriously impaired.

"That, however, is not the end of the injury; for when accumulated by evaporation around the crown, the alkali absolutely corrodes and dissolves the bark, as it does the humus of the soil causing a dead ring around the butt, and finally girdling the stem as effectually as could be done by a knife, or even worse, because the wound is poisoned and the wood attacked after the bark is gone.

This difficulty," he continues, "does not exist in the case of "white" alkali soils; they till kindly and the only trouble lies in the accumulation of the salts at the surface in consequence of evaporation to such extent as to injure the surface roots and root crown."

How to convert the "black" alkali into the "white" type and thus eliminate the destructive properties of the former, is a serious question that confronts the agriculturist. This may be done by a liberal application of land plaster (calcium sulfate.)

Sodium carbonate (black alkali) plus calcium sulfate equals calcium carbonate plus sodium sulfate (white alkali.)

Furthermore, the gypsum renders the humus insoluble and it retains its original function as one of the soil ingredients. It is also a valuable fertilizer for leguminous and broad-leaved plants. Land plaster scattered freely upon manure heaps and in or about stables or sheds will catch and hold fast the escaping ammonium carbonate, giving it up in due time to the growing crop. Gypsum beds should, therefore, be sought for in the State that the article may be brought within the means of the consumer.

Thus far in the discussion of the alkali problem, I have endeavored to make clear to the reader the term alkali soils, their composition, their prevalence in certain sections of our State, the benefit to be derived by irrigating them, and how the effect of the alkali upon the growing crops may be modified by under-drainage and deep tillage, and the application of land plaster; also the natural deduction that the proper treatment can be decided on only after the soil has been submitted to a chemical analysis to determine which of the injurious constituents predominates.

In the meantime the agriculturist must practically demonstrate what are the most

AVAILABLE CROPS FOR ALKALI SOILS

based upon the ultimate purpose of said crop. Alfalfa has been found to be a most valuable and thrifty plant, the dense leaves thickly shading the ground while its deep roots absorb nearly all the water and dissolved salts, thus reducing evaporation to the minimum. Root crops, as potatoes, carrots, turnips, cabbage, beets (not intended for sugar production), sowed corn and other ensilage crops may be successfully grown. The small fruits and the grape, prune, pear, apple and peach, may be profitably raised when the alkali is not too strong. The Experimental Stations will early inaugurate such tests for the benefit of the farmer.

WORK OF THE CHEMICAL DEPARTMENT.

The purpose of the Government in establishing the Agricultural Experiment Stations was clearly set forth in Bulletin No. 2 of this series. The Board of Regents of the University of Idaho has manifested no less interest and determination to bring the work of the stations in touch with the people at the earliest practicable moment. The Central Station is less than one year old; the Faculty still younger. The opening of the year found nothing in the line of equipments for the use of the several departments.

Scientists know very well that experiment stations which are to contribute permanent good to the State, as well as the departments that are to prosecute the work, are matters of growth. Plans cannot be formulated and results reached in a few months that will posses definite value. As one who is familiar with the development of Station work in the East, the rapid growth of the University of Idaho and the organization of the Station Council is remarkable, in my judgment, in view of the fact that the Government fund was not available until the present fiscal year.

LABORATORIES.

The Chemical Department of the University dates from the first of the year. One small room only could be spared for class-room and laboratory instruction; supplies had to be secured from the far east; and yet, at this date, the department is very well organized and prepared to do analytical work for the State. With the completion of the university building, the department will be assigned to permanent quarters, comprising an office and weighing room, a qualitative laboratory, a quantitative laboratory, a metallurgical and assaying room and a lecture room, all of which will be available for investigation in agriculture and kindred sciences.

To meet the demand already made upon the department has necessitated a large outlay of funds for Station equipment, which will be considerably augmented during the summer.

LINES OF INVESTIGATION.

In the near future the management will undertake a series of systematic soil and clay analysis collected from typical sections of the State, especially from regions effected by alkali; waters intended for sanitary and irrigation purposes will receive special attention; fertilizers offered for sale within the State will be examined that the consumer may be protected against the use of the adulterated article; coal and other fuels will be analyzed to determine their value for factory and domestic purposes; the beet sugar industry will be given early consideration, so also will the examination of dairy products and various foods offered for household consumption.

The department will utilize every available means to make itself a prominent factor in the development of the resources of the State that come within its province, and requests the co-operation of all interested parties.

No investigations will be made gratutiously intended to advance the private interests of corporations or individuals only, but such experiments and research undertaken whose results will aid in increasing the material and social wealth and health of any community or of the State at large, and add to the sum total of scientific knowledge.

HOW TO MAKE COLLECTIONS FOR ANALYSIS.

DIRECTIONS FOR SAMPLING WATERS.

The source, use and final disposal of the water supply of a family, a corporation or a community, are such important factors in the development of a state and the health of its people, when considered in connection with the chemical analysis, it has been thought best to append herewith detailed directions for sampling waters, that the Station may early enter upon such investigation. That these analyses may be of the greatest value it is not only necessary that the samples be taken from many and widely remote sections of the State, but that every precaution be used to secure water free from outside contamination.

1. For sanitary or technical analysis not less than one gallon should be sent; if complete analysis is desired, as for irrigation, or to determine its effect upon boilers, or for city use, send two gallons of an average sample.

2. Use only glass bottles or demijohns as containers; stone jars, metalic vessels or casks must not be employed. Thoroughly cleanse the vessel with boiling water, then rinse several times with sample water. Treat the cork likewise, if not new. Secure cork in place by tying with string; never use wax, plaster or putty.

3. In all cases, take water to be sampled direct from the spring, well or hydrant. Should a gas escape from the spring, secure a sample by inverting a

bottle filled with water over the bubbles. After the gas has displaced all the liquid, cork tightly under the water. Also send a sample of efflorescence, if any is caused by the water.

4. The sample should be plainly and accurately addressed and should be accompanied by a statement giving information on the immediate surroundings of the well, spring or river flow; depth of same; source of supply and whether abundant or meager; effect of rain or drowth on the volume; some account of the strata through which the well or flow has passed; temperature of water, if hot; and whether intended for domestic, steam or irrigation purposes.

Forward all packages by express, charges prepaid, to:

AGRICULTURAL EXPERIMENT STATION,
University of Idaho,
For the Chemist. Moscow, Idaho.

GATHERING SOILS.

1. The surface soil is the portion usually submitted to analysis, and as such usually includes the first ten inches of earth. If the subsoil is to be inspected also, carefully separate the two layers that they may be separately analyzed.

2. Select samples in their natural condition, untained recently by artificial or natural fertilizers. Scrape away decaying vegetable matter. To obtain an average sample, select about two pounds from five or six parts of the field and endeavor to secure a typical soil of the locality. Mix thoroughly the several portions; remove any stones, roots or foreign matter; dry in open air and pulverize, but do not destroy any mineral fragments contained therein. Place eight or ten pounds in a clean wooden or tin vessel, tightly covered, address and ship as indicated above. A detailed letter of information should accompany the sample.

4. Soils sampled according to these directions

will be analyzed and a report made thereon at the close of the year.

COLLECTING PLANTS.

That the Stations may early secure a complete list of the Flora of the State, interested parties are requested to send in wild plants for determination. Specimens should be either in flower or fruit, or both. Of small herbs, as annuals, the entire plant—root, stem, flower or fruit should be sent. If the plant be a large one, secure some branches and the lower stem leaves, also enough of the root to determine whether the specimen is an annual, biennial or perennial. Not only the flowering plants but flowerless forms, such as ferns, mosses, lichens, algæ, fungi, etc., are desired.

2. That a record of the specimens may be preserved, if possible the statement accompanying the plant should include such data as: Locality; nature of the soil; whether growing on upland or lowland; abundant or rare; whether locally regarded as useful or injurious; date of flowering and fruitage; date when collected.

3. Wrap carefully in paper, place in large envelope or between folds of stiff pasteboard, with the least possible crumpling, and mail, prepaid: "For the Botanist," etc.

4. Any information concerning the Flora of the State will be thankfully received and correspondence is earnestly solicited.