Foreword to Agricultural Meteorology by Sir John Stuart Forbes of Pitsligo

The Transactions of the Highland and Agricultural Society of Scotland
July 1853 - March 1855

This reprint (probably typed around 1950) was recently found in my archives. There is no sign of the original publication which dates from 1855.

The author, Sir John Stuart Forbes, owned and farmed the family estate near Pitsligo in north east Scotland. The article was written at an interesting time. Admiral Sir Francis Beaufort (1774 - 1857) had his Beaufort Scale officially accepted by the British Admiralty in 1838 and in 1854 the UK Met Office was formed as a small department within the Board of Trade, under Captain Robert FitzRoy (famous for commanding HMS Beagle on Charles Darwin's historic expedition), to provide meteorological and sea current information to mariners.

The then Captain FitzRoy RN is mentioned in the paper as having recently been given the task "to receive logs and construct the wind and current charts, &c., and to interchange the results with other nations".

In this historical context, it is encouraging to find references to topics such as agricultural sustainability, agro-climatic zones, topo-climatology, climate modification (shelter and soil drainage) and some of the earliest plans and costings for synoptic networks.

The Author

Sir John Stuart Forbes, the second son, became eighth baronet, on his father's death, 24th October, 1828. he was born 25th September 1804, and married 14th June 1834, Lady Harriet Louisa Anne Ker, third daughter of the sixth marquis of Lothian, and had a daughter, Harriet Williamina. He died May 27, 1856, and was succeeded by his nephew, Sir William Stuart Forbes as ninth baronet. He was born June 16, 1835, and married July 1, 1865, Miss Marion Watts, and has issue. Anderson, W. The Scottish nation (extracted from http://web.ukonline.co.uk/ewh.bryan/forbes7.html).

The Professor Forbes mentioned on page 8 may well be the younger brother of the author as his brother (James David Forbes) was elected professor of natural philosophy at Edinburgh University in 1833.

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AGRICULTURAL METEOROLOGY,

by Sir John Stuart Forbes of Pitsligo, Bart.

Though the influence of climate upon agriculture is one of the few subjects upon which both practical and theoretical writers are quite at one, it is rather remarkable how very much it has been treated, on the one hand, as an element of uncertainty in farming operations, with which it is quite impracticable to deal, and, on the other, as a mere matter of scientific speculation.

Climate may be defined as the influence of the average temperature, the amount of moisture, and the direction and intensity of storms, modified by the physical characteristics of each particular district.

That climate does practically exert a most important influence upon every operation of the husbandman, is easily demonstrable. Even on the natural produce of the earth, the recurrence of the seasons, with their varying phases, in different years produces continual variety. How much greater must that difference be when they operate upon exotic plants and foreign animals, stimulated to an unnatural state of precocity and delicacy, and upon the soil itself, when it is forced into an artificial power of production beyond its normal condition? Much may be done by ingenuity, lavish expenditure, and continual watchfulness, to protect our animals, secure our crops, and save the enrichment of our fields from exhaustion by rude exposure, at seasons when experience teaches us they are likely to suffer; but, after all, from not being able to predict the recurrence of atmospheric changes, we are often misled in our arrangements, and our efforts to protect ourselves are frequently misplaced and neutralised. All who are engaged in agriculture are experimentally taught their subjection to such alternations, by the overthrow of their most careful calculations. We are caught by a sudden change of weather with our dung-heaps half made up; the roads are blown up with snow, and they lie exposed in our helplessness; our wheat-sowing is delayed to an unseasonable period by a deluge of rain, or the land undergoing the most delicate preparation for root crops is burned with drought, so that a comparative failure is the return for the utmost attention assiduity, and skill. Independent of these occasional causes of disappointment, the season never suits alike all the crops and all the soils our rotation obliges us to cultivate, and an inferior amount of produce from one or other is always expected. Besides these practical proofs of the effect of climate, of which every farmer has in his own case bitter experience, the shortest excursion will show him the effect of change of position in neighbouring districts, or a longer tour will give him the example, in foreign countries, of the entire revolution in the system of agriculture necessitated by the simple change which latitude produces.

Under such circumstances, which render the very recurrence of seed-time and harvest almost a marvel, recognising, as we do, the uncontrollable force of providential arrangement in their distribution, the inquiring mind of man could not rest satisfied without ascertaining the law of so many unestimated forces, limiting his power, and counteracting his efforts. He set himself to work, by scientific investigation, to remove as much of the uncertainty as possible, and long-continued observation has done something towards laying down a general principle in the grand features of the subject.

The branch of scientific inquiry conversant with this subject has, however, made very slow progress. The great outlines of physical geography, dividing the earth into zones, and, under the guidance of such travellers as Von Humboldt, characterising their different products, give systematic fixity to observation in natural history; and the study of currents or ocean-streams, and of the consequent prevalent direction of certain winds, have aided navigation: but the minute attention requisite to apply the results to any particular locality, under its own varying circumstances, so as to regulate the practical operations of agriculture, has been only very recently, and as yet most imperfectly, applied.

That such investigations bear a most important relation to those practical operations will be obvious, when we consider that many of the elements of the influence of climate - such as the actual average degree of heat and cold; the weight of the atmosphere, suggestive of so many of its changes, and indicative of its condition, whether damp or dry; the quantity of rain or snow that falls; the direction, prevalence, and intensity of wind from different points, and the degree and continuance of sunshine - are all appreciable, and can be registered from observation of instruments we use; while the varying circumstances of latitude, altitude, exposure, soil, and the disposition and arrangement of the surrounding physical features of the country, modifying the general laws in any particular locality, are all equally subjects of inquiry and accurate estimation.

Science in this, as in other directions, has certainly of late years made more rapid progress. The idea of a cycle of years which should regulate the recurrence of known atmospheric phenomena, whicl was so favourite a theory among meteorologists of the last century, is nearly exploded, - more probably from the want of prolonged, minute, and attentive observations, than from anything inherently absurd in the principle, which, on the contrary, is rather in harmony with the systematic order of action visible in other atmospheric phenomena; but even this idea is not beyond the pale of legitimate investigation. In like manner, the influence of the moon, though often scouted as almost superstitious, is so generally recognised by those practically employed in rural affairs and supported by such a series of remarkable coincidences, that it is not to be excluded from free discussion and rational inquiry.

If such speculative subjects are still open, we have in the progress of physical geography a large amount of recently acquired and most important information on the influence of the great features of our globe upon climate and production. Professor Forbe of Edinburgh, in his recent work on Norway, has given some very curious/

curious details as to the effect of local circumstances upon average temperature. He remarks, "It is no longer necessary to invoke violent displacements of the earth's axis, or the atmosphere of a comet's tail, to alter our climates and desolate our continents. The submergence of Europe to a small extent in the ocean, a diversion of the great oceanic currents, or an alteration in the mean dampness of the air, would alter all the conditions of life on our continents, and clothe them with abundant snows such as we find in the southern hemisphere."

The effect of the intensity of summer heat in counteracting the operation of a low average temperature is illustrated by the fact, that at the North Cape, the average temperature being 32° of Fahrenheit, which would bring the line of perpetual snow to the sea-level, it is actually raised by the summer heat to about 2800 feet. Rain in the higher regions is not supposed to melt one-fiftieth part of the snow which falls in winter; it is therefore by the summer heat that the melting of the snow, and in lower regions the power of vegetable production, is chiefly influenced. The large masses of land are cooler than the ocean in high latitudes, and hotter in the tropics; hence the snow-line is in the interior of Norway about 1000 feet lower than on the coast. The influence of oceanic currents is seen in the absence of drift ice on the Norwegian coast even as high as 71° N., while on the North American coast it is abundant as low as 41°; and the harbour of Bergen, latitude 60° , is frozen only two or three times in a century, like the Seine at Paris; while Copenhagen 56°, and Lubeck, 54°, are frequently blockaded by ice. In like manner, the rain which falls on the west coast at Bergen is several times greater than that at Christiana, nearly the same latitude on the east; and the contrast between the latter place, with its abundant forests, fruit-trees, and flowering shrubs, and Shetland, treeless and bare, covered with morasses, and enveloped, even in summer, in fog, is a most convincing proof that parallels of latitude are far from being safe measures of similarity in climate and agricultural productions.

A striking proof how correctly the isothermal lines, as traced by Von Humboldt, and laid down in Dove's Tables, indicate the character of vegetation by average temperature, was afforded by Von Buch's observations in Norway, who calculated, from the elevation at which the pine ceased to grow, the average temperature of a place within a quarter of a degree of the result arrived at from accurate observation of the thermometer for eleven years.

The first person who applied these important principles with a practical view to the climate of England was, it is believed, Mr. Whitley, land-surveyor, Truro, who, in the English Agricultural Journal, No. XXV., drew many very important conclusions from the variety in average temperature in these islands. The difference from the south of England to the Orkney Islands is about 5°, or 1°for every 111 miles, while a similar difference is found in about half the distance from Greenwich to Cork from east to west.

The difference round the island, at least as far north as Aberdeen, on a sea-board of about 2000 miles, does not exceed 4° between any two places; thus proving the truth of Humboldt's observation, that latitude has less effect on general temperature in these islands than in any other part of the world, which later researches/

researches corroborate. But, as has been already remarked from the Travels in Norway, the average annual temperature, though the power of climate is generally measured by it, is in truth a much more fallacious standard than the distribution of heat throughout different portions of the year in its influence on vegetation. The anomalies which we meet with under this head are indeed startling. Thus we find that, in 1796, when the Thames was frozen over, the mean temperature of the country for the year fell only one degree below the average of a number of years. Again, the mean temperature of the month of January is only 36°near London; while it is 38° 5' at Wick, in Caithness; 39° 5' in Orkney; and 40° in Shetland, - that is as mild as Avignon, and little colder than Florence, which is 17° of latitude farther south. How, then, do we account for the difference of produce which can be raised? Simply by the fact that there is nearly 10° of difference in the average temperature of the summer months. The average summer heat in the valas of Yorkshire is 62°, the vale of Severn 64°, and Cornwall 60°; while we have only 58° at Leith, and 52° in Shetland.

The above facts are all important in the estimate of the effects of temperature upon vegetation, and give a new and practical direction to our observations in the science of meteorology as applicable to agricultural produce. In a merely abstract scientific view, they are very curious, as showing the effect of currents in modifying mean temperature, from the peculiar position of these islands, in the throat, as it were, of the great northern stream, which rushes from the tropical to the frozen regions; and it is in this light they have hitherto been generally regarded.

The measures adopted for measuring these variations have not, even in a scientific view, been commensurate to their interest. The only consistent and extended plan of operations which has yet been adopted is in Ireland, through the energetic efforts of Dr. Lloyd, the able president of the Royal Irish Academy of Dublin. That learned body directed their attention first to the subject methodically early in 1850, since which time observations have been carefully made.

With that liberality with which successive governments have long distinguished Irish enterprise, the officers of the coast-guard stations were ordered to procure regular returns according to the directions of the Society, who voted a sum of £225 for instruments, and further raised a sum of £126 for gratuities to the coast-guard men who kept the registers. Through the kindness of Dr. Lloyd I have received a copy of each of the later reports of the academy, with lists of the instruments employed, and their cost, as well as the instructions arranged in concert with Sir John Herschel, and issued to the observers. Dr. Lloyd has promised to furnish as many copies of them as may be required to explain the course of proceeding; and has sent, moreover, his papers on the theory of the movement of storms - a most important subject for nautical inquiry, taken up by Mr. Stevenson of Dunse, whose interesting observations on the general character of our storms have also been contributed.

This minute register of the movements of the atmosphere, and careful observation of the direction and intensity of storms along/

along the coast, cannot be without its use even as a contribution to the special object which we at present have in view; but it will not accomplish the whole; for the influence of elevation, the amount of rain, point of condensation, and the great variety of accidents in exposure, soil, and local position, as regards the physical conformation of the surrounding surface, materially affect the result as soon as we leave the coast. This is the point to which the present movement is proposed to be directed, because it is as yet confessedly very little understood from previous investigation; indeed, its elements are so various that every special situation must have its observations as a guide to its agriculturists.

This is sufficiently proved by what previous researches have already made known. From many observations on the coast, 270 feet of altitude has been taken as equivalent to 1° of average temperature, and in many situations that obtains pretty accurately; but see what discrepancies meet us at the very threshold of the inquiry In Mr. Whitley's table, carefully constructed from observations, in most cases, for several years, we find the following:-

	Mean temperature for the year.	Do. summer.	Altitude.
Leith,	48° 36'	58° 27'	Sea level.
Bonally,	44 21	54 65	1100 feet.
Difference	4° 15'	3° 62'	

This agrees as nearly as possible with the above estimate; but see another case in the north:-

	Mean temperature for the year.	Do summer.	Altitude.
Aberdeen,	49° 18'	59° 33'	Sea level.
Alford,	45 08	56 46	420 feet.
Difference,	4° 10'	2° 87'	

Here we see the difference of average yearly temperature nearly the same as in the former case, with a difference of altitude not much more than one-third; while the summer average, though a little less disproportioned, is quite beyond the application of the rule. We surely cannot have a stronger proof that elevation alone, in the same latitude, is no just criterion of productiveness. Equally uncertain are the results in trying to discover the law by which local circumstances of altitude and exposure affect the condensation of moisture as exhibited by the rain-gauge. It is reported upon trustworthy observations that the depth at the top of Westminster Abbey is 12 inches, while it is 18 inches on the roofs of adjoining houses, and 22 inches on the level of the ground below. Mr. Whitley mentions the anomalous effect of situation in many cases where conflicting results seem to defy the discovery of any uniform principle. Thus he cites places at the base of very elevated ground where the amount of moisture is much greater than on the adjoining height; while, on the authority of Mr. Miller of Whitehaven, 2000 feet of altitude is supposed to be the point of greatest condensation; and at Kinfauns, near Perth, 140 feet above the sea/

sea, the fall of rain is 25 inches, and on the adjacent hill, 600 feet high, it is 41 inches.

It remains now only to show how perfectly M. Von Buch's observation - that, as a general law, the natural power of vegetable production will correspond with the average temperature of any locality - may be carried out in cultivated plants; and this is amply proved in Mr. Whitley's ingenious article above referred to.

All our crops usually cultivated have been originally imported, and are to be considered exotics. Though now domesticated, the effect of acclimatising is uncertain, and of very limited action, which is ascertained only by long experiment, with the aid of science, as to the circumstances under which we may safely trust to receive a remunerative return.

Wheat is probably a native of Asia Minor; and in Lombardy, where it is completely naturalised, it enjoys a summer temperature of 73° ; in Sicily, the ancient granary of Rome, 77°. In 1727 a small field of wheat, near Edinburgh, was considered a marvel; and for steady good crops of wheat a summer heat of at least 59° is required in ordinary seasons. Below that temperature, in the west of England, it requires a very dry season. Thus in 1840 the spring was cold, which made the plant tiller; and though the summer heat was 1° below the average, it was dry, and produced a fine crop. The cultivation of wheat is nowhere pushed at so low an average temperature of summer heat as in this country; and the consequence is, as a table of good and bad crops for seventy years shows, a deficiency of only 2° or 3° of summer temperature puts the whole crop in jeopardy.

In Scotland, where our summer heat rarely reaches 59° - the average of twenty-six years at Hopetoun House, for example, being only 58° - the length of the day appears in some degree to compensate for a low degree of heat; and the crop can be pushed, in good situations, with tolerable success even at 56½° or 57° .

We need not follow this chain of observations. It applies equally to all kinds of crops; and surely the legitimate inference must be, that accurate observations of the average temperature, the summer heat, the condition of the atmosphere, and the direction and intensity of storms, in every possible variety of altitude and exposure, must be essential to the highest advancement of methodical agriculture.

One point of extreme importance in this estimate appears to be still undecided: by what laws the distribution of heat over the season is regulated. In one part of Mr. Whitley's valuable essay, he says that the character of the spring is generally extended to the summer - a cold spring being followed by a cold summer; but as the average temperature throughout the year differs so little in the coast-side stations, where registers have been kept, it seems that a sort of compensation must occur. It is very plain that an approximation to a theory upon this point may be reached, from the fact that shrewd observers in the country seldom miss a season for the operations of husbandry, however sensitive to these fluctuations; and though Mr. Whitley admits that the observations, more or less correct, of seventy years constitutes/

constitutes nothing to the assurance of anything like a cycle of years in the recurrence of seasons, and Mr. Lowe, in a pamphlet published on the signs of the weather, demolishes the authority of most of the usual indications, if we could obtain a regular series of observations on meteorology in different localities, many useful cautions might be deduced for practical guidance.

The health of our animals is no less dependent upon circumstances of situation and climate than the return from our crops. They, too, are in an artificial state, - if not in all cases by improvement of race, at all events by greater delicacy of constitution, and consequent value of produce, than the hardy natives of our unreclaimed pastures. The most careful treatment may be neutralised by a short period of accidental exposure; and an intimate knowledge of local fluctuations would be of vast importance for bringing to the best account our stock in different districts.

Such a careful abstract of prolonged observation, with a judicious digest of laws and principles legitimately deducible from them, would have a wonderful effect in giving confidence to our proceedings and regularity to our results. It would methodise our improvements, and enable us to measure their effects. Thus, shelter is indispensable for tempering our climate; but when too close or continued, especially in low situations, the want of circulation condenses the moisture into hoar-frost, and checks early vegetation. So drainage increases the average temperature of the earth, which in inland situations improves the quality of the air; but we have no systematic measure of the extent of this improvement. The common observer will perceive that the snow disappears sooner on drained land, that the grass plant and wheat are not cast out of it by frost; nay, grain merchants will perceive a change in the character of the sample, the form of the pickle, and quality of the husk; and the farmer may imagine that, on an average, harvest is earlier: but these are isolated observations, which require the corroboration of well-attested fact for authoritative promulgation. Who would doubt that the two-and-a-half millions of drainage money had been well spent by agriculturists, if it could be satisfactorily proved that a degree of average summer temperature had been obtained for every million sterling?

Taking it for granted, then, that the case for agriculture is completely made out, many circumstances lead to the conclusion that the present is a most favourable moment for agitating the question. What is pressed, however energetically, by one interest only, may be coldly received, when it would be cordially taken up and influentially promoted if backed from a variety of independent quarters - the combination of the various classes proving irresistibly the public demand for action upon the subject. Now, this seems to be very much the position of affairs in regard to inquiry into atmospheric phenomena at present.

It has already been shown that Dr. Lloyd and the Royal Irish Academy have long been engaged on the subject, under the patronage of Government; and that Mr. Stevenson of Dunse, in correspondence with him, has been elucidating it with special reference to the theory of storms. Then we have Mr. Whitley, in Cornwall, and Mr. Stewart of Hillside, Lockerby, in Annandale, engaged with the practical view of its effect upon rural affairs; and new allies/

allies have sprung up in the persons of Dr. Moffat at Hawarden, in Cheshire, and Mr. Richardson of Mortlake, in Surrey, who, on the part of the question bearing on the public health, have lately prepared an elaborate report for the Epidemological Society. From all these parties the most cordial assurances of co-operation have been received. Dr. Lloyd has offered assistance by communicating the regulations upon which the Irish observations are conducted; and Dr. Moffat remarks, "It is suggested that Government should take up the sanitary branch of the subject by managing the whole machinery of the stations through the Registrar-general, and that the same hands might work out the skeleton at least of the observations for rural purposes, under the direction of the different observatories." He anticipates that if the medical profession, and scientific men in general, combine with the mercantile community Government will not be able to withstand the pressure.

This appears a very correct view; and the opportunity of effecting such a combination should not be lightly rejected, as we see what an impulse has been given in England to the question of agricultural statistics, by the union of commercial men with the country party urging it upon Government.

The next point, and that the most important, is the mode in which the inquiry is to be carried out. And first, as to the different branches it should comprise, upon which some difference of opinion may exist. In the Irish observations, conducted by the coast-guard at only thirteen stations on the coast, it is somewhat elaborate, comprising barometrical as well as thermometrical observations, the instruments for which cost about £10 for a set; but the Doctor thinks that a more managable and cheaper form of barometer than that which their committee have adopted might be used. In the valuable suggestions by Mr. Whitley, herewith presented, he names eight stations, on the coasts of England and Scotland, at most of which registers are already kept. For these he proposes, in the first place, to provide no barometers, and thinks the other instruments might be supplied to the whole for £50. He farther suggests a common understanding between the two great agricultural societies on the subject, and obligingly offers, if the two societies unite in carrying out a joint system, to undertake the reduction of the observations and preparation of a paper embodying the results for the two journals. Professor Forbes, in his recommendations to the Norwegian scientific bodies to undertake such a series of observations of mean temperature, suggests that fifty stations should be selected, and that they should, in like manner, be confined, in the first instance at least, to the results of the thermometer and the rain-gauge. Mr. Charles Stewart, Hillside, Lockerby, has long given his attention to this subject, and got up on a small scale a very efficient system of returns. There are eight parishes where registers are kept in the upper district of Annandale under his direction, and it is believed that the same arrangement will be made in Eskdale, under the auspices of the Duke of Buccleuch. These eight parishes comprise a district of twenty miles in length and six to eight in breadth, which is a good beginning, especially as the work seems to be carried on with hearty and cordial interest by the schoolmasters, who have been engaged to make the observations. Mr. Stewart's idea is, that such a system might be indefinitely extended by the private interest of a certain number of gentlemen in different localities, who/

who would undertake to work a certain number of parishes, not making it, however, strictly parochial, but fixing upon a certain number of points, to give a fair average of each district. It is plain, however, that even to secure uniformity and moderate price in the instruments, as well as to obtain a proper reduction, comparison, and digest of the observations, a cordial co-operation would be required, such as the societies could offer; and to extend the sphere of observation to many kindred objects beyond the mere ascertaining of the average temperature and the quantity of rain that falls, a national combination of the various interests to which, for different objects, the inquiry is interesting, would be the only efficient means of obtaining and making available results worthy of reliance and of the great interest of the subject.

It appears that in the United States the scheme has been most completely systematised. Through the kindness of Mr. Stewart the report of the Regents of the University of New York, which they have presented annually for above sixty years, is submitted, in which above thirty-five academies report monthly a digest of observations on the mean temperature, the direction of the wind, character of the weather, and quantity of rain, accompanied by a great deal of interesting information regarding the physical peculiarities of each season. Physical science is gradually obtaining a considerable degree of attention in our country schools also, and the keeping of such registers by the school-masters would have a decided and useful tendency to concentrate and increase it.

A great mass of observations is accumulated at the office of the Northern Lights, and these, it is to be hoped, Government would be at the expense of reducing and publishing. As to the general scheme of practical operations, the following remarks of Captain James, of the Scottish Ordnance Survey Department, come from so competent an authority that no apology is necessary for pressing them upon the attention of all concerned:-

"The establishment of a Meteorological Society in Scotland appears to me the best plan for effecting this object; and if, amongst the members of the Highland and Agricultural Society, and others interested in the science of Meteorology throughout Scotland, we could obtain about 400 subscriptions of one guinea each annually, I have no doubt the object could be effected. We should then be in a position to ask the support of Government, and I think we should receive it. You would then be able to appoint a properly qualified superintendent of the observatories, whose duty it would be to communicate with all the local observers as to instruments, form of registers, &c., and to receive, discuss, and publish the results. The schoolmasters would probably make good observers in the interior of the country, as the coast-guard men would for the sea-board; while the observations taken at the lighthouses, at the several colleges, and at private observatories would also be available. I would recommend uniformity of system for the United Kingdom, and a mutual interchange of the public results in the three kingdoms between the different societies.

"At the conference held at Brussels last year, a uniform system of meteorological observations to be taken at sea, by the vessels of all nations, was agreed upon; and our Government has/

has appointed Captain Fitzroy, R.N., to receive the logs and construct the wind and current charts, &c., and to interchange the results with other nations.

"A second conference is now proposed and advocated by the most eminent meteorologists in Europe and America, to arrange a uniform system of observation on land in all parts of the world, and for an interchange amongst the nations of the results obtained in each, and thus to bring together the results systematically taken over the globe. A meteorological society in this country will enable Scotland to take her part in this combined system."

It remains only to press very urgently upon the Directors of the Highland and Agricultural Society, as they have manifested a warm interest in the subject by appointing a committee to receiv this communication, the propriety of farther recognising its practical importance in an agricultural point of view, by co-operating in the measures for carrying out the object, and using their influence with the Society in recommending it to the notice of the proper authorities and the country generally.
