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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COMMANDING OUR WEALTH[1]

By Dr. ISAIAH BOWMAN

PRESIDENT OF THE JOHNS HOPKINS UNIVERSITY

"If we command our wealth we shall be rich and free."—*Edmund Burke.*

IN his Quebec broadcast, August 29, 1943, Prime Minister Churchill spoke of marching forward to the end of the present military struggle when "the whole world may turn with hope, with science, with good sense and dearly bought experience, from war to lasting peace." Possessing "all the grand comprehensions," as he once said of Lord Rosebery, Mr. Churchill included science among the forces to be employed in the creation of a lasting peace. He was not betrayed by the shallow observation that men have used science for destruction, nor did he erroneously conclude that science causes war. If one may venture to extend his statement: hope, science, good sense and experience are four hard-riding horsemen equipped to lead the procession of victory in the post-war years.

[1] Address of the retiring president, American Association for the Advancement of Science, Cleveland, Ohio, September 11, 1944.

THE FOUR HORSEMEN

Among the banners of victory there will also be represented justice, religion, the freedoms and generosities of humanitarianism, and all the arts in which men strive to express the instinct for beauty and enjoy the creations of disciplined taste. The four horsemen who carry these banners represent the benevolent and spiritual virtues. We may agree that they should be in the forefront of the procession and one day may be when their noble rank is more generally recognized. Whatever the place of the second group of forces, the faith for which they stand must surely inspire hope,

science, sense and experience, whether material or humanistic. We address ourselves, however, to one theme at a time in order to speak clearly. On this occasion the main theme is pioneer settlement, a sector of science that bears on the welfare of the world's expanding populations.

Science implies a critical attitude and habit of mind as well as specific ways of dealing with objects, qualities, measurements, relations and processes that are searched out. It is a habit that most men acquire with extreme difficulty. The subject of this address illustrates the difficulty. With uncontrolled hope, misunderstood science, little sense, no experience and a comfortable armchair, a case can be made out for settlement (by the other fellow) in almost any part of the marginal lands of the world. The difficulties begin when we put living and aspiring persons (not statistical units) in specified places and examine the problems that arise one by one in their actual social context, not an imagined context. The difficulties mount when we see what real people become under new and often extreme field conditions and not what imagined people ought to become to satisfy a thesis.

Experience and good sense, two of our four horsemen, provide the basis for a judgment on what a given group *can do, or will do, or may be persuaded to do* with respect to settlement in new lands. This judgment itself is also a part of the social context, for policy-makers can not rely on dreams only: they have to act in large part on experience with named persons at given points on the map. Men in action posts can not safely ignore the strength of the logic of things. At least they must always relate the here-and-now to their dreams. The mind and body of a pioneer do not float in space; they have desires that are expected to be realized in an understandable and acceptable (or endurable) economic and social system, whether presently existing or not. The third horseman, science, goes a certain distance only in aiding either settler or policy-maker. Scientific findings can not give a final answer as to the success or failure of a given settlement project. The settler's own will, aptitudes and preferences are a part of the picture. Is he determined? Can he walk and not faint?

The words "success" and "failure" are themselves relative and any conclusion about them rests on rather abstract assumptions. Rate of progress in achieving a settlement goal illustrates the point. If the rate of progress is too slow there is no real progress at all. That is, new crops or cultivation techniques, or greatly changed prices, or new transport facilities, or community improvement or deterioration, or neglect of health or nutrition, may incite or compel new experiments that contradict or modify conclusions based on earlier trials under different conditions.

Phases of Settlement Problem: Refugees, Overpopulation, Resources

The general problem of land settlement now includes the special problem of refugees. For more than ten years the world has been deeply concerned about their placement and future. Can they succeed in new lands available to them overseas? Will the end of the war find their number increased or substantially diminished? Will the devastation of war reduce the sustaining capacity of Europe? What does it take in the way of shipping, loans, land engineering and social services, to plant even 100,000 persons, not to speak of millions, in new lands under conditions that will create a sense of attachment?

Beyond the question of refugees is that of overpopulation, so-called. Will the rapid growth rates of certain European populations create a demand for overseas migration from areas alleged to be incapable of supporting more people? Do there actually exist empty or under-developed lands that are desirable places in which to live? If desirable climatically and economically, do such lands have undesirable social limitations? What is the nature of the political barriers to the migration of desirable stocks? What changes in world economic conditions may modify the intercontinental migration problem, perhaps fundamentally? What does science contribute to the problem of land occupation? What are the psychological difficulties in applying science to land-settlement thinking when a migrant group undertakes its great adventure?

This by no means exhausts the list of inquiries that bear on land settlement. Nor do the variant solutions of the problems of settlement necessarily depend upon decisions about refugees and post-war migration. For land settlement, as a part of the wider problem of the development of the world's resources, may be desirable regardless of distant population pressures. That wider problem urgently demands consideration because the war must and will be paid for and the better use of available resources is one way of creating the means of payment. How payment will be made depends upon our intelligence, our will, our courage, our enterprise in utilizing the wealth of the world. Science is a part of our stock of intelligence and enterprise. Shall we pay for the war by merely shifting economic burdens from strong to weak countries? Shall we pay by a lowered standard of living and wide unemployment and social confusion? Or is a rational and creative program possible? It is a truism that there is wealth enough in and on the earth for human support and welfare if we are able to command it intelligently.

Resources are property that must be used more in-

telligently (that is, less haphazardly) than ever before if the costs of the war are not to crush us. Adapting a quotation from Burke: resources may be among the impediments if we allow the artificer to be encumbered by his tools. The "efficient" steel plow has hastened soil destruction in parts of Africa as well as Tennessee. Slope soils and hoe culture have had a long historical enmity, east and west. Mill owner and ship owner contended for 500 years over their conflicting uses of English rivers, each believing the other's "tools" an encumbrance. The stunted orchard trees, with paper-thin rings of growth, growing over some of the "cones of depression" in the water-table caused by the pumping stations of Long Island, picture a rivalry for water, the clamant city dwellers of New York winning the contest.

In the post-war years we must make finer adjustments of means to ends and an ever finer choice of values in the development of natural resources if we are to win economic security for ourselves without excluding security as a right and proper goal for other peoples too. Not alone fuller use of resources but also wiser choices in their development are required. Peace through world organization may become a fading hope if we do not sustain the will for it by distributing the incredible cost of war justly while repairing the immediate devastation and dislocation of it.

Peace a Condition of Living

No one nation is resourceful enough to achieve security and a high standard of living while leaving the rest of the world in a post-war wilderness. We once trusted in our own isolated strength and never were we more dangerously and cravenly led. The power we boasted of was industrial and not immediately military: it took four years to reverse the action at Dunkerque. This is indeed "dearly bought experience." Will it be remembered? Critics once repeated by rote that the peace of Versailles had done all the mischief of the two succeeding decades as if any peace whatever, even a theoretically perfect one, could cancel out the destruction of the war that preceded it. World war cracks if it does not break diverse and interlocking societies and the processes of repair are many, complex and slow. Repair by inspiration is no repair at all. A paper declaration—the Kellogg Pact, for example—may be worse than nothing with tremendous talk about it merely creating a false sense of having done something. Self-delusion may be cultivated by a signature on a piece of paper. Unless positive and concrete action follows, a treaty may merely advertise disquiet.

A treaty of peace should be an agreement about continuing action, not the eternal repose implied by hopeful preambles. That is why peace should be, from now on, the business of every citizen, whatever his calling. We must all do something about it, now and hereafter, to-day and every day, down all the generations forever. Keeping the peace has become one of the primitive and permanent conditions of living, coequal with food, clothing, shelter. Upon it rest vast hopes of future spiritual accomplishments. Without it any report upon "the state of the Union" is fatally incomplete. The state of the Union now includes the state of the world.

Limits of Political vs. Scientific Methods

One of the roots of the tree of peace is science. From root to crown there is a continuous flow of discovery, for modern civilization insistently demands new and improved forms of satisfaction and security. The creative powers of science can quickly make up some of the losses of war. We need new industries more than ever, more idle land put to use in new ways and old, more soil conservation, a scientifically determined balance between conflicting forms of land-use and water-use, better bodies and far better minds. Work and hope and sense and science and experience by and in our people will assist in the creation and application of these things. If we leave their creation chiefly to government we shall become "encumbered with our tools" and dampen creation. For government is at least half politics. There is, perhaps inevitably, great waste and too little rationality in it. Politics, defined as partisan rivalry, is by its nature largely an emotional process. It is all the constituent parts of our society in the pot boiling.

Many political processes are merely forms of adjustment and compromise. They are essential mechanisms for keeping a nation united, but they are not fundamentally creative. If we define a desirable civilization as the sum of accepted humanitarian ideals that are in process of realization, then civilization implies awakening, creation and experiment in many fields of knowledge and social endeavor. The play of social and intellectual forces that inspire progress in civilization thus defined has little in common with the play of evanescent beliefs, errors, circumstances, emotions, and misrepresentations that mark partisan struggles. There would be no politics if there were not persons endowed with the instinct and skilled in the art of keeping an ear to the ground, their own direct and personal interests mingled with the real as well as the supposed interests of constituents. "That fine sensibility to outward impressions, that nice *tact* of circumstances, which is necessary to the consummate politician"[2] are combined with "rules of political

[2] Hazlitt, "Winterslow."

arithmetic" for the mere manipulation of a group of social forces.

The other and desirable half of government is harnessed to social need, staffed by devoted and trained men, lifted to higher levels of principle and action by great thinkers, judges and statesmen, idealized by the songs and heroisms of a people, stimulated by remembered things that generate great emotional and emulative drives. These are a few of many useful political processes. They provide strength through idealism coupled with honest work. They are among the primary sources of political cohesion in times of danger. Out of them, chiefly as taught in the schools, grow the folk judgments that now and then in a democracy correct the nation's course when deflected by the vanity and selfishness of politicians. It is the dearth of such forces in the international field, coupled with commercial rivalry, fear and suspicion, that has made cohesion for peace the major problem of civilization to-day.

Common Denominator and Cooperation

What all men everywhere share is an interest in livelihoods. Some look for an opportunity to make a living, others put living ahead of opportunity, but their common denominator is a living. Livelihoods are in scientific discoveries, skills and aptitudes; in social, economic and industrial organization; in the wide and more diverse use of land (internationally as well as locally) and of the things that grow on it, in the cultivation of varied human aptitudes and in peace that permits men to plan with greater assurance—to mention but a few factors. And the enjoyments of a livelihood range over the whole gamut of human folly and wisdom. That is one reason at least why a good scientific program of resource development can not always win on its merits alone. It is hard enough to identify or agree on "wisdom": it is harder still to secure its adoption by a given society.

If we aim at wise international cooperation we face still greater difficulties. "It is a thousand times harder to take international action than it is to suggest it, however eloquently. Even when men have their feet firmly upon their native heaths they are slow, wordy, and political: in the international arena they stand knee-deep in shifting sand."[3] The nonlogical motivations and actions of social masses form one of the major themes of Pareto, who gave them a deserved emphasis. It is the counsel of weakness, senility or despair, however, to suppose that bad social and political trends are irreversible, that the wave of a black future is predestined, that "the world" is moving willy-nilly toward an imagined goal of evil.

[3] Graham, "The Fish Gate," p. 177. London, 1943.

Intelligent men, we say, put their trust in "the larger hope." When faced with hard alternatives, they make their choices through the play of the critical faculties, seasoning realities with dreams. If strains and tensions contributary to war are recognizable in the population contrasts of the world, are there rational solutions? If so, do they appear politically feasible? Whatever may be the political setbacks and irrationalities of the hour, science moves forward on the wings of creative work and of hope. Dealing in part with tangible "things," science is also a great teacher of meanings. Back of the things discovered are a philosophy and an attitude that have had profound effects upon most non-scientific research as well. And the meanings are always new and exciting, for one of the greatest discoveries of science is that the march of creation never halts.

A few case summaries of land settlement in their social context will now be discussed. This will include the political context because land settlement, conceivably a scientific experiment, has never been separable for long from the political programs of the states in which it takes place or from which migrants come.

During the past eight years, building on earlier field studies (1907–1932), I have been examining systematically the character of about thirty possible settlement areas. The techniques employed in these studies, like those of science in general, are often exciting in themselves; and when their results affect public policy they are doubly so because of the difficulties which the human will introduces and the forces that are manipulated by politics. I am speaking, to-day, however, not in the technical terms appropriate to an audience of professional scientists only, but rather in the general terms appropriate to the discussion of a social problem of interest to us all, for I remember that the American Association for the Advancement of Science is now a large family of over 25,000, not to mention the millions who read about science or listen to a radio address.

Italian Settlement in Libya

Men commonly act on beliefs, not demonstrated truths. But the results of such action are beneficial in the field of natural resource development only if they are in conformity with truth, whether by accident or design. The settlement of Libya by the Italian government, greatly speeded up in the two years before Italy entered the war (1938–40), serves as an example. After the Turco-Italian war of 1911, scientific studies were begun in Libya and Eritrea. In 1923 and 1928 there were new settlement undertakings, but they failed to encourage significant migration. There was no question about the underdevelopment of the "Fourth Shore." Given capital upon

which little or no return is expected, and almost any region anywhere can take more people and expand production. Political expediency fostered a belief in the population capacity of Libya (Tripoli on the west, Cyrenaica on the east) far in excess of any reliable scientific findings concerning resources economically available under long-range plans. Reports were prepared by men who had to prove quickly that Fascist guesses were right. Where 30,000 wells had served the oases of Tripoli, 800 were added. A deep artesian zone (1,200+ feet) was tapped without regard for the possible long-range effects of the high mineral content of its waters upon irrigated fields.

Choosing the best land, and largely disregarding the prior summer grazing customs and needs of the native tribesmen, the government hurriedly spent $20,000,000 to establish 1,800 individual farms upon which 20,000 persons in large families were placed (October, 1938). That is $1,000 per person or from $8,000 to $10,000 per farmstead. It is $2,000 per person if we add certain free services and grants to settlers while they were establishing themselves. A rigged market and the avowed general expansion of Italy's African territory were among the other aspects of the venture. The rising resentment of the subjugated desert Arabs (including the Senussi), whose winter pastures in the adjoining desert had already been overgrazed, was one of many heavy disabilities. What was gained was supposed to be a political and technological triumph.

Let us assume that another 20,000 or even 30,000 could have been supported by the agriculturists through the services of the towns and in transport and government. The total is 50,000, while the annual population increase in Italy is normally around 300,000. Even this small percentage of relief, limited in effect to a few years as a population outlet, may be important for the siphoning off of restless youths trained in technology and government; but it does not solve, it only alleviates microscopically, the general crowding it was supposedly designed to alleviate.

The fanfare about the magic of scientific desert reclamation could not conceal the fact that Italian colonization in North Africa raised new and grave political problems. Native participation in benefits was largely excluded because of a nomadic way of life, or limited to aided Arab settlements on the poorer agricultural land on the ground of their alleged "lesser requirements." Italian population and political problems were not solved by settlement in Italy's African possessions: they were merely changed in psychological form and shifted, in small part only, from metropole to colony.

Native rights and native interests establish an account that calls for strict examination. Smaller in scale than Hitler's seizure of Poland and the Ukraine, it is the same in kind. It is "lebensraum for me and the desert for you." The land prepared for Italian settlers in Libya had not been idle. Its carrying power may not have been fully utilized, but it was a necessary part of a nomad economy affected by violent fluctuations of pasture: Azizia, in the steppe region southeast of Tripoli, and 25 miles from the sea, had 10 inches of rain in 82 days in 1929 and five inches in 31 days in 1927. Tripoli town had a rainfall of 6.5 inches in 1915 and 29.8 inches in 1894; Cirene had 4.7 inches in 1915, and 53.1 inches in 1924.[4] Only in rainy years is there "a sea of grass." Colonization here has been described as "a magnificent gamble," the dry farming minimum being eight inches. In Cyrenaica were located 820 of the 1,800 farms mentioned above. With greater elevation (900 feet), the rainfall on the uplands is 12 to 16 inches. Dry farming and forage, olive and other tree crops are the rule. A narrow higher zone with a rainfall exceeding 20 inches has small tracts of cypress and pine "forest" and a much wider intermediate zone of bush and scrub alternating with steppe. In Libya in general the range of crops is limited by extreme daily and seasonal ranges in temperature. Rainless summers and high winds increase the handicaps.

Every venture in settlement, whether sound or not, is of scientific interest. Political morality aside, what colonists do on "the edge of the possibilities" provides guides or warnings to policy-makers and technicians elsewhere. One observes, however, that wide advances and retreats are as likely in our scientific day as in the days of Roman conquest. Two thousand years ago Augustus tried to limit the northward raids of the town-pillaging nomads who had been elbowed out of their better pastures. Though Tiberius in 24 A.D. crushed a revolt in North Africa, raids continued along the inner borders of the coastal belt. In 45 A.D. the proconsular province (Tunis) was attacked from the south. The record discloses repeated and serious revolts in Numidia and Mauretania on the west. In the second century, reservations for native tribes were marked off, an improvement on the policy of driving the nomads into the more arid south. Even in those distant centuries the relations of soldier settlement and native economy had their complexities; and the choice between wheat and olive cultivation then as now raised problems in the effectiveness of capital applied to labor and water.[5]

The political changes of our day can not fail to produce forced contractions of settlement as well as

[4] V. M. Sullam, *Foreign Agriculture*, Vol. 8, pp. 159–168, 1944.

[5] T. Frank, "Economic History of Ancient Rome," 1933–1940.

artificial expansions. The nomads may be expected again to drift their flocks over some of the more marginal sites of hopeful colonists. The tentatives of cultivation are visible around every desert site from Morocco right across northern Africa. The iron law of high rainfall variability has widely ramifying effects, political and otherwise. It is an old field of conflict. The promoters' arguments of the twentieth century Fascists had been worn threadbare by the Caesars.

The economic artificialities of Libyan settlement are shared in some degree by most tropical lands where commercial agriculture has been developed. The sequence is well known: stop inter-tribal wars and slavery, expand modern health services, establish a cash-crop system, and some of the populations of the warmer lands grow incredibly—1,000 per cent. is the increase for Java since 1800. Java was an underdeveloped country, relatively speaking, when the large-scale treasure hunt began with the growth of natural rubber, oils, gums, minerals, tea, spices, sugar, fibers, woods and quinine. The production of all these things was swept upward as the world market expanded and plantation agriculture grew in efficiency. It is now one of the most crowded lands in the world.

The production and marketing of tea, a tempting experiment for marginal settlers in parts of tropical Africa, illustrate the difficulties that confront either the scientist or the government when attempting to fashion a rational program.

TEA AS AN ILLUSTRATION

The least important question in tea production is where tea will grow. If all the lands capable of producing it were cultivated there would be an immense over-supply. Scientific selection and management of the best sites would avoid excessive soil depletion, increase efficiency, and thus enhance the welfare of the local producer, if only the price were stable. But variations in price prove far more important than limits of tolerance of soils and of tea plants.

Immediately after the first World War a slump occurred in the tea industry from which there was recovery with rising prices from 1923 to 1927. In this interval considerable areas of new tea were planted which came into bearing by 1928–1929, when supply again exceeded demand. An attempt at restriction proved abortive and by 1932 tea production was entirely unremunerative to almost all who were engaged in the industry. Thus was provided the impulse for the International Agreement of 1933 which involved India, Ceylon and the Netherlands East Indies. The producers initiated the scheme and provided the strength to sustain it. Experience has led the controlling bodies to recommend agreements between governments as an added advantage while keeping private initiative. It was sought to secure equilibrium between supply and demand but, to do this without harm to the existing producers, an International Tea Market Expansion Board was established. No attempt was made to regulate prices. Special effort was made to increase the consumption of tea. It was felt by the board that regulation of supplies without active steps to expand markets through "continuous and intensive propaganda of every description" would provide no remedy for over-production. While for the moment large parts of the tea-growing territory are shut off by the war from world consumption, the return of peace will find the problem looming again, unless all tea expansion is brought under control and acreages are limited.

The need for control measures is felt particularly in pioneer territory such as Nyasaland, where the tea industry has been described as "a stream of life blood."[6] By 1938, nearly half its exports (by value) consisted of tea (9 per cent. in 1932), whereas the figure for Japan runs less than 1 per cent. Tea culture requires both capital and a cheap and skilled labor supply or one capable of becoming skilled. This puts foreign control on one side and native labor and production on the other. The question then arises, What should be given and what received? Who is to judge? Foreign control puts a hand upon the intimacies of economic life and government of a community and one need not look far to see both native advantage and dislocation. The agricultural experiment station in Mlanje, Nyasaland, engages in tea production research, but, important as the work has proven to be, it is not enough. A bridge must be built between the scientific findings and the social results.

In the end a decision about land use anywhere is a decision about how to put things together, economics and science working hand in hand. Labor and markets have a direct relationship; capital, subsidies and taxes have their connections; and other sectors of opportunity require constant reappraisal. Thus, in Australia, "Seasons, soils and sales form the trinity" affecting the present front of settlement and future advance, with economic controls the most aggressive.[7] The mosaic of social use is of interest to all of us now, wherever we live. When half of our people live in the cities we can not legislate for either city or country alone. We have to put things together. We have even to take account of the effects of differing tastes. To take a single example, Costa Rican coffee is the most favored of the British market. In 1932, a fairly

[6] R. U. Light, "Focus on Africa," 1940, p. 83.

[7] S. M. Wadham and G. L. Wood, "Land Utilization in Australia," p. 336. Melbourne University Press, 1939.

normal year, 30 to 40 per cent. of the total coffee imports of the United Kingdom came from Costa Rica.

CHOICE OF ESSENTIALS

It may be assumed that well-organized peoples work within the limits of more or less deliberate choices of essentials as modified by the accidental and the unpredictable. To-day the people of the United States insist on a high standard of living as one choice among a number of essentials, because access to the world's wealth, or the power to create it, are now taken for granted, thanks chiefly to geographical discovery, the inventions that have grown out of modern physics and chemistry and the crop changes due to plant introductions and plant breeding. In England the post-war standard of living at times has seemed as important as the war itself. Housing now has first priority in post-war plans, civilian supplies second, and manufacture for overseas trade third. It is held that the war will not seem won to the returning soldiers if decent places to live in are not assured.

How to marshal our forces in support of the great ideas we intend to live by has now become one great essential. Resource development is tributary to that. We can not lay out the lands and dominions of the world and disinterestedly observe where and how development should proceed to give us a rational scheme. We are not free in this respect. Our fate is now bound to other lands far and near. There is no such thing as pulling out of a world war or the peace that follows it. The fine net of world circumstance entangles us all. This is the political context of land settlement and resource development from now on.

If this reasoning be sound we must look at marginal lands not as permitting but rather as compelling action. Some of the largest tracts are in the British Empire. Canada and Australia have too few people, considering the territory they embrace and its strategic value. It is urgent business to fill these under-developed lands. The population structure of the British Isles is such that a decline is forecast to 32 millions by 1976 (Carr-Saunders). Half the assumed rate is alarming enough. A general overseas movement from Britain to the distant Dominions is therefore out of the question. Where shall the non-British migrants be found who will most readily people the Dominions? In Europe certainly, but this clearly means the designation of desirable stocks, encouraged migration and a certain measure of accelerated nationalization. The last-named is necessary for purposes of unity (through education) in essentials of community life, and for the political cohesion that self-protection demands. If migrants are without education in the history and traditions of the country to which they migrate, or the capacity to benefit by them, they may weaken a nation in a period when cohesion and strength are matters of life and death.

If there is agreement on these essentials we must aid the settler in choosing the best lands for given crops, the best cultivation techniques for quality and the best market conditions as well as the limits of production in relation to price levels. The virility and imagination which Mackinder invoked on Britain's behalf in 1902 as he looked at the perilous facts of British geography, demography and power, are now most urgently required by all of us. The insularity of the British Isles is only different in degree from that which marks the present situation of the United States. Our great strength is sustained in part by drawing upon a wide range of foreign products. Any human stock that has staked out its portion of earth as the home of free institutions must now effectively occupy and defend what it claims. Having chosen a course, every support that science, sense and experience can bring should be marshalled to people the best remaining lands with assimilable stocks capable of making a sound choice of essentials.

The word "assimilable" is important. Political unity is short-lived unless continuously nourished. Land settlement in the post-war period starts with people. Land is secondary. We can not create a special citizenship bound to the land. Only the serf and the bondsman are so restrained. It is alleged that the only Venezuelan agricultural colony settled by immigrants since the colonial era that has survived to the present time is Colonia Tovar. It is in the Coastal Cordillera, 22 miles from La Victoria and was founded by Codazzi a hundred years ago. W. D. Rasmussen concludes that its unique success is a reminder to Venezuela "that it would not be advantageous to have the Nation's unused land settled by isolated frontiersmen on a subsistence level or by nationalistic groups. Social and economic integration are essential."[8]

The integrating powers of states differ as much as their physiography and economic life, education, sports, speed and volume of circulation of newspaper and mails, and all the other attributes of culture differing so widely. That is why a world-imposed theoretical plan of settlement would most certainly fail, whereas national programs inspired by disinterested local studies of a scientific nature may succeed.

OVER-ALL CONDITIONS: A BASIS OF JUDGMENT

If the limits of land settlement are to be drawn strictly on the basis of immediate economic returns there will be no general venturing. Success demands an immense excitement about settlement, but an excitement controlled by a choice of essentials, the social

[8] W. D. Rasmussen, Colonia Tovar, Venezuela, *Agric. Hist.*, Vol. 17, pp. 156–166, 1943.

context, the scientific findings, the deliberate choice of things it is meant to do and pay for, whether they are economic or not. Sound conclusions as to what is or is not economic in pioneering are few in number. Medical science has a good word for the assemblage of over-all conditions upon which a judgment must be based. The word is "syndrome." It is defined as "a group of signs and symptoms that occur together and characterize a disease." Fever is the accompaniment of many diseases. The same is true of pain. But one diagnoses a given case by the things that occur uniquely together.

This "occurring together" is characteristic of each type of marginal land. It is worse than useless, it is misleading, to say that the average rainfall of a certain area is sufficient to support good crops four years out of five and therefore it is safe to engage in wheat and barley cultivation or cotton or corn. The interpretation of rainfall in terms of crops is but one factor in an extremely complex set of circumstances.

Each crop and each method of cultivation must be studied in relation to each soil type, each vegetation type, each rainfall type, each slope gradient, in combinations that must be analyzed fundamentally and not in the light of a particular political thesis. Good objects from one standpoint may be achieved at the expense of other equally good objects.

> The station holder [of New Zealand] most "efficient" in the eyes of his neighbors . . . (in that he frees his hill country of weeds) is often the first to be driven off his holding by advanced erosion. Soil losses are widespread and serious and it is evident that remedies successfully employed in the United States can not be used in New Zealand without considerable modification. In individual regions the problem is unique: each region will require its own solution. The immediate and urgent need is for research and experiment. Effective soil conservation implies the kind of use and treatment of land that exactly fits its capabilities and needs.[9]

The example of tsetse fly control illustrates a conflict of purposes and results that can only be resolved by intensified scientific studies. Each of the 21 species of fly has different habits and different requirements as regards vegetational habitat. These differences bring each species in contact with different combinations of food animals. Each species also has a range of habitats.

> Hence the subject resembles the song of the "Ten Little Nigger Boys." As you find the solution for one type of country, nine types remain, and so on. But we are finding one thing in common for all the tsetses; each requires more than one vegetational type at a time, and the types it requires must be in contact with one another to support it in all seasons and years. We call this "concurrence of requirements."

[9] Kenneth Cumberland, *Geog. Rev.*, Vol. 34, pp. 77–95, 1944.

Glossina morsitans, for instance, needs savanna wooding to rest and breed in, and vleis to search for food in. Continuous uniform savanna wooding will not support it, while ant-heaps with heavy vegetation, near or at the contact of this and the vleis, add much to the suitability of the general vegetational concurrence.

This simplifies the problem very greatly. It means that you need eliminate, by planting or otherwise, only one requirement of the tsetse at one season of the year—or (it may even be) of an exceptional year—in order to eliminate the tsetse.[10]

Conflict of purpose is underscored in the final report of the Drought Investigation Commission of the Union of South Africa (1923). The destruction of the natural vegetation increased soil erosion while decreasing the underground water-supply, thus making more difficult the watering of stock. Complaints having been made by farmers that the planting of catchment-areas in South Africa with fast-growing conifers and eucalypts has diminished the dry season water-supply in certain streams, a special committee of the Fourth British Empire Conference in 1935 considered the problem. In view of contrary evidence and the concurrence of a period of diminished rainfall, the complaints were discounted; nonetheless the committee pointed out the desirability of a comprehensive scientific investigation into the effects of tree-planting on local water-supplies. The lack of scientific knowledge through controlled experimentation could only be made up by precautionary advice. Quoting again from "Colonial Forest Administration":

> In the meantime, in order to allay public anxiety, it was suggested that where water conservation was a vital matter, fast-growing exotics should not be planted at the actual sources of streams and the eyes of springs, where, however, the natural vegetation should be carefully protected. There has never been any question as to the value of the indigenous forest as a means of conserving and regulating the water-supply.

The limited application of scientific results from a single area is a truth that drives home the need for intensive studies, area by area. The combination of controls, risks and needs is often unique. The warning is given that,

> Because the white farmers on the karroo sediments of the Cape Colony, or on the dolomites of the western Transvaal have been saved by an energetic policy of providing bore-hole water with the aid of "forests of windmills," a similar policy will not necessarily help nomadic Masai or semi-nomadic Sukuma on the old metamorphosed schists or granites of Tanganyika Territory.
>
> In Tanganyika Territory, as elsewhere, the layman is apt to shout for irrigation schemes without knowledge of

[10] C. F. M. Swynnerton, "How Forestry May Assist towards the Control of the Tsetse Flies." Appendix II in R. S. Troup, *Colonial Forest Administration*, pp. 439–40. London: Oxford University Press, 1940.

their implications. Only recently one read in *The Tanganyika Standard* . . . the following statement . . . "Vast areas in the Territory are entirely waterless. This can be altered by a series of canals from which irrigation streams could be made." It all sounds so wonderfully simple and straightforward!

Matters with regard to first cost, salinity and lack of suitable soils become even worse in those parts of the territory where, in the absence of perennial rivers, irrigation of the reservoir type would have to be resorted to. One is, therefore, forced to the conclusion that large-scale irrigation schemes should be left severely alone and that in the light of a recent fuller understanding of the complications of climate, soils, hydrography and markets the early optimism of the Germans regarding the possibilities of such schemes can no longer be upheld.[11]

BRAZILIAN AND PERUVIAN EXAMPLES

A useful contrast has been drawn by M. L. Cooke, in "Multiple Purpose Rivers,"[12] between the São Francisco River in Brazil and the Amazon, the Amazon being limited by the fact that it is not a "multiple-purpose" stream. Throughout its course in the lowlands there is no opportunity for electrical development and no proven coal deposits. By contrast the São Francisco Valley has a good alluvial floor, irrigable acreage "as much as that of cultivated Egypt," and good sites for dams and power plants that would extend water control and power development and provide the manifold services and opportunities that now make the valley "socially inert for lack of a plan."

Social inertia has many facets. Is its source in diet or the extent of the tradition that manual work signifies reduced status? Or is it due to the prevalence of malaria and dysentery? Is a bad transport system contributory? The settlers from Ceará, a region of recurrent droughts, plus others from Rio Grande del Norte, Paraíba, Pernambuco and Alagoas, represent a new migration drift through the São Francisco Valley;[13] 160,000 left Bahia for São Paulo between 1936 and 1942, a large number from the valley itself. From the port of Joazeiro the bulk of the migration tide moves upstream by riverboat. Permanent settlement in the valley, despite the tide of potential settlers, is scant and the population density remains low because of the inflexible pastoral pattern and the semi-aridity.

The slightest increase in population is apt to upset the delicate balance between population and resources which has been achieved as a result of the natural ebb and flow of humanity over a period of centuries "and may easily strain beyond the limits of elasticity the carrying capacity of existing wells or pools, natural or artificial. Not until the vise-like grip of the present extensive economy is broken and the use of the water rationalized, can there be sufficient progress in the valley to make possible an increase in population."

The settlement possibilities of the Amazon have always stirred the imagination of travelers, sometimes for and more often against intensified occupation. Some overlook the profound handicaps of isolated settlements as set forth in a useful medical survey by M. H. Kuczynski Godard,[14] of the selva of the Rio Perené in Perú, with a chapter on Amazonian colonization in general. No report shows more clearly the necessity for writing the terms of settlement of the Amazon Basin and its borders in their social context rather than in terms of the imagined possible. It is immensely costly to give modern medical services to settlements so widely dispersed, and health conditions are in general deplorable. Godard emphasizes the desire of enterprising persons to leave the region for more comfortable and more sanitary places, a negative migration which steadily drains off the best. There results a tendency on the part of white settlers to remain stationary, primitive, morbid, hopeless. This brutal land is a sign of God's power, wrote Bustos, in the purple terms of the romantics. If we say that the Indian has adapted himself to it, the answer is given that to master his environment he has spent all his energy and has done nothing more. He exists without change. His religion is magic, and tradition and fear perpetuate it. For the whites, education, medical services, and enterprise through outside aid are prescribed. Government recoils at the expense. It is held that there are safer and more comfortable places for enterprise.

The border of the Amazon basin may one day display a different aspect. That border is an empire in itself. It has the climatic and vegetative diversities of varying altitudes. It has access to the highlands on the west in Bolivia, Perú, Ecuador and Colombia. It is the exception to the gospel of land scarcity in Perú, as set forth recently by R. A. Ferrero.[15] Relaxation from the continued high temperatures and relentless humidity can be found most readily by locating settlements near the upland mountain borders of the basin and at moderate altitudes. Local air conditioning in the lowland plains will give temporary relief, but it is no substitute for a change of scene and climate.

Of social life in the pioneer zones of Brazil, in general, James writes that "the 1938 immigration decree

[11] C. Gillman, "A Reconnaissance Survey of the Hydrology of Tanganyika Territory in its Geographical Settings," *Tanganyika Territory Water Consultant's Report No. 6*—1940. Government Printer, 1943.

[12] *Journal of the Franklin Institute*, Vol. 237, pp. 251–64, 1944.

[13] Raymond E. Crist, "Cultural Cross Currents in the Valley of the Rio São Francisco," *Geog. Rev.*, 1944.

[14] "La Vida en la Amazonia Peruana," 1944.

[15] "La Escasez de Tierras Cultivadas y sus Consecuencias." In "Tierra y Población en el Peru." Lima, 1938.

requires that each colony established in the pioneer zones must have at least 30 per cent. of people born in Brazil, and not more than 25 per cent. may be composed of foreign people of any one nationality." In the rural schools part-time instruction must be given in Portuguese, and Brazilians must direct the schools.

> The possibilities of settlement in the pioneer zones of Brazil can not be understood or predicted from a study of the physical quality of the land alone . . . the kind of people who may desire to undertake the settlement of Brazil's pioneer zones can not at present be identified, nor can we know what political and social ideas or what technical abilities they will bring with them. Beyond a program of mapping, analysis of the physical quality of the land, interpretation of the present patterns of settlement and of past experience on different kinds of land, the prediction of future population capacity involves too many unknown factors to be profitable.[16]

Meanwhile the problem becomes more and more pressing:

> Brazilians have become increasingly worried over the doctrine that vacant land is the patrimony of mankind and should not be allowed to remain idle while millions of humans live on a low standard because of lack of sufficient land. . . . The millions of acres of absolutely unused lands in Brazil, the failure to develop the rich deposits of iron, manganese and other minerals caused a natural uneasiness, a recognition that weak nations have always been absorbed by strong ones, that as Bismarck once remarked, natural riches in the hands of those who do not know how to develop them, nor care to do so, are a permanent danger to the possessor. . . .''[17]

Regional Framework of Settlement

The problem of future migration and settlement is complicated by runaway population growth in a few countries and the demand that other countries make room for the excess no matter at what cost to social and political cohesion and living standards. Here politics, religion and national ambition are joined fatefully. There can be only further trouble in the international field if we assume that the subject is one so delicate in politics and religion that it may not be talked about. It is equally dangerous to follow the course advocated during the past few years and deny the importance of national boundaries as if one could change them freely to suit the changing demographic conditions of the world and let populations stream out in every direction at will. Such a policy of progressive revision would be an invitation to constant emotional pressures, to ingenious inventions of argument, to the destruction of treaties by violence, to the undoing of every form of international cooperation.

The possibilities of greater concentration of population in the already densely peopled industrial regions has been emphasized during the past twenty-five years. Primary production requires no forced expansion of settled areas, so long as technology supplies new avenues for investment and employment and corresponding concentration to suit the expanding tastes and diversified needs that technology has already stimulated. As new industries make new demands upon primary production in overseas lands, especially in tropical areas, both the income standards and the demand for manufactured goods will be raised.

> The unemployed in European industrial areas would then find employment at home in producing the things exported to tropical countries. . . . The need for emigration decreases with the opening up of such opportunities at home, and as this process is both theoretically in accord with the tertiary stage of industrial development, and has already been occurring on a large scale in practice, we must infer that centripetal movements of population are likely to be more important than centrifugal in future. In a reasonable world the European is likely to benefit most by the elaboration of his skill in his own land. Given a relaxation of economic barriers, ''Europe is perhaps of all parts of the world the best suited to support a larger population.'' If this dictum seems surprising it is only because we have fallen into the error of confusing high density of population with population pressure.[18]

The theory has been advanced and merits close examination "that differences in density were not causes but rather results of migration, that the basic cause of migration lay in differences in standards of living not necessarily correlated with density of population." An Italian example illustrates the point. The greatest increase in the rate of emigration during 1876–1925, concludes Forsyth, was in sparsely-peopled agricultural districts, "a fact showing 'the falsity of the prevalent opinion that there is a direct relation between emigration and density; in fact no such relation appears and in many cases the reverse relation is found.'"

The mounting scale of home investment in all countries is emphasized by many analysts; likewise the requirement, in overseas agricultural settlement on any large scale, of very great capital sums. "If a country complaining of surplus population could find these sums it would do much better to consider first whether the money could not be better used at home in stimulating industry so as to furnish employment and raise domestic standards, permitting meanwhile such emigration as could take place without public assistance."[19]

[16] Preston E. James, *Michigan Academy Sci. Arts and Letters*, Vol. 25, pp. 385–95, 1939.

[17] Bailey W. Diffie, *Hispanic American Hist. Rev.*, Vol. 20, p, 426, 1940.

[18] W. D. Forsyth, ''The Myth of Open Spaces,'' pp. 62–64, 1942.

MIGRATION AND BOUNDARY STABILITY

To change national boundaries capriciously would be the highest folly, in my opinion. We can not undo two hundred years of history by light-hearted talk about the rearrangement of the populations of the world, as if densities could or should be smoothed out. To attempt to do this would at once bring into fatal conjunction differences in food habits, in standards of family life, in that virility and choice of essentials that are required successfully to defend one's own against robbery by war, and in all the other things that we label culture or purpose or ideals. Populations are not mere aggregates of numbers densely peopling the earth here and lightly peopling it there. We must look at the moving spirit of each aggregate. If purposes and ideals disappear, then we are mere livestock and our fate does not matter. It is the ideal toward which we strive that gives our national life a purpose. All these things confront us when we think responsibly about changes in national boundaries. We can not overlook the importance of property lines, legal administration, taxation and all the other attributes, powers and responsibilities that go with political and purposeful control of specified territories. The nations will certainly not mingle land titles and effects any more than they will mingle codes and culture systems or water them down to some common scheme that means nothing to anybody.

To be specific, free migration and elimination of boundary restraints would not solve any identifiable problem to distribute the annual increment of five millions of Indians in other countries. It would only weaken, confuse and distress the rest of the world. Whatever outside responsibility there may be, the Indians also must do something at home about that increment. As for outside responsibility, consider the shipping required to transport overseas five millions, or even one million per year. Consider the social services required to establish them in new places. Consider the communities that they would form of unlike peoples with ideals, historic backgrounds, culture systems, family life, religion, etc., so unlike their neighbors in their new environment. And there would be neighbors almost everywhere. A million Indians can not be dumped into the Amazon basin in a given year or in five years, for the supply of social services is at a minimum there and adequate services can not be improvised: they require time for seasoning through experimentation. Power, humanely exercised, has the responsibility of saying how it would absorb what that number of settlers would produce from a forested and savanna terrain. Brazil has the responsibility of saying whether she desires an Indian empire in the Amazon, were one possible of creation. Whether we assume its divisive political influence or its economic and social failure, the problem would be on Brazil's shoulders if she ever attempted so bizarre a social enterprise as wholesale settlement of immigrant Indians in Amazonia. Social and political cohesion worries Brazilian leaders now: they are not likely to invite an enlargement of the area of difficulty.

The nature of some of the problems that arise when two cultures are placed side by side may be inferred from the experience of Fiji. In 1940 nearly half the population was Indian (98,000 out of 220,000).

> Indians have picked out many pieces of good land near native villages and leased them, and the improvident Fijian has been compelled to carry on his agricultural methods on poorer land farther away from his native community.
>
> . . .
>
> The "use" of land in the mind of a native is not confined to his need for an area large enough for growing foodstuffs. He desires to retain freedom to search for wild food, for materials for building houses, and to hunt for wild pigs.
>
> . . .
>
> Young Indians assert: "There are thousands of acres in Fiji not being used. We are British subjects and we want some. We were born and reared here." . . . The question of landownership and land use is not only important to those who own the lands but is also of vital importance to the Indians who have made their homes in Fiji. Bound up with it is the future welfare of the colony. Native chiefs passed a resolution in 1936, asking, in effect, that the government should control for them all the lands they did not require.[20]

We have already noted inequalities of population density, opportunities, standards of living and political ideals that are bound up with questions of migration and settlement. Back of these inequalities is a conflict of philosophies. In the world of the future a balance of ideas as well as a balance of power may have to be reckoned with. Some students believe that industrialization will start, or at least accelerate, the desired cycle of conditions that lead to reduced birth rates. Others contend that this will endanger the world's peace by placing greater power in the hands of politically immature peoples.

In a broken world, migration on a large scale is not politically feasible. Employment is an intense preoccupation for the city half of our population. The war has taught us the crucial need for internal unity. The risk of turbulence implied by the wholesale shifting of populations is shunned by every country. The occupation of the remaining lands, a highly desirable end, thus becomes an outward growth from established

[19] Carl Alsberg, "The Food Supply in the Migration Process," in "Limits of Land Settlement," pp. 50–51, 1937.

[20] J. W. Coulter, "Fiji: Little India of the Pacific," pp. 116–19, 1942.

bases, here a little and there a little, with science and government sharing the task, the factors of time and personal initiative taken into account.

SCALE AS A FACTOR

The sense of enterprise which permeates successful settlement endeavor depends nowadays upon well-selected sites and a certain scale. Population centers of 3,000 to 5,000 are required, as well as smaller centers and individual farms, if the varied services that make new homes acceptable are to be supplied. To develop smaller towns or isolated villages of a few hundred or to go back to lone pioneering is to call for too great a change in the way of life of present-day settlers. The larger size will also have a conspicuous effect in drawing population from nearby well-settled areas where there may be less opportunity for land development. And it is the extension of settlement from already established localities that provides the bulk of the population of pioneer groups. The Inter-Departmental Committee on Migration Policy, reporting in 1934, has a significant statement on the matter from the particular standpoint of British overseas settlement.

> . . . We find it very difficult to believe that organized group settlement could deal with, at the most, more than 2,500 families—say, 10,000 souls—in a year; neither the localities, nor the capital, nor the administrative capacity for anything in excess of this—or perhaps for anything as large as this—are available. There are, however, no limits, other than the absorptive capacity of the Empire overseas, to the magnitude of the stream of migration which may be produced by the other method. [The prospective settler migrating with his family on his own initiative or that of a friend or relative.] It was by this method that, in the ten years immediately preceding the war, over 148,000 migrants annually left the United Kingdom and settled in the overseas parts of the Empire. In the ten years 1919–1928, the annual average migration produced by this method was over 132,000. We are convinced that it will be by this method, individualistic, and therefore congenial to our national bent, that the great bulk of migration from this country will always take place. . . .

The extremely important point is made that schemes for settling thousands of families overseas in new communities tend to impress the public by the magnitude of the organization involved, the sums expended and the new names of towns on the map. The bustle and publicity of ship chartering, port building, road construction, cooperative buying and selling and the selection of a balanced population containing the right number of farmers, tradesmen, professional men —all these activities create a stir and excitement that are alleged to have no corresponding practical results when it comes to the real business of counting new settlers and appraising their staying power on the land. But it would be more correct to say that the excitement is out of proportion to the results, thus recognizing the possible value of excitement.

The two methods are not mutually exclusive. The bulk of the lands available for settlement, out of a world total of perhaps three million square miles, can be occupied by self-initiating settlers. There are some areas, however, that require substantial capital investments if success is to be attained. Government will be called on to take the risk of supplying such capital if the objectives include national security or other non-economic ends. We all remember the wide and sustained public interest in the irrigation projects of the U. S. Reclamation Service following the turn of the century. "Homes for Millions" became a popular slogan. Yet when the 24 national irrigation projects had reached the point of substantial development in 1926 there was a total farm population upon them of only 137,000. By contrast, in the two decades preceding, motivated by individual enterprise, there were over 600,000 final entries under the Homestead Act, in addition to coal-land and desert-land entries.

What the Reclamation Service did was important and desirable. It undertook the large capital venturing beyond the means of the individual farmer or the small group. Were such capital venturing to be undertaken for petroleum exploration in Alaska, for example, in parallel with advanced agricultural experimentation, it is possible that the struggling settlements of the pioneer fringe of Alaska would take on a new lease of life and that the enlarged scale of operations would create the excitements and sustain the hopes that are necessary for permanent occupation. But in the end it would be the push, virility and enterprise of individuals that would constitute the final test of staying power and attachment.

CONTRASTS IN NATIONAL INVENTORIES

The contrast between east and west, about migration and land, in part grows out of our different purposes in using it. Land in China is for subsistence. Land is food. With us land is one factor in the complicated problem of (1) keeping up a standard of living on the land so as not to sink farmers to the level of peasants; (2) balancing the benefits of total production, city and country, through the intricate mechanisms of an industrial society.

We do not bring all our land into full production because we already have a surplus production. (I will not venture into the tangled question as to whether or not this is only a commercial and not a social surplus.) By contrast, land division in India and China has been carried so far, under growing population pressures, that tens of millions are at starvation level.

The problem facing governments is how to ease these conditions before Australia becomes an adjunct of India or China. Economic easement in China seems a far more rational solution than merely keeping Chinese out of Australia. If white settlement in Australia is urgent, it is equally urgent to begin the industrialization of China. The balance of ideas and opportunity may thus become a sufficient substitute for the balance of power.

There seems to be a high correlation between prosperity in new lands and migration to them. Historically that prosperity has been in turn dependent upon the power of industrial centers to buy the raw materials of the producers of the newer lands. If the post-war world enters an era of expansion (to supply the losses of war and delayed consumption demands) there seems to be a clear possibility that the former relation of industrial areas to raw material areas may be substantially regained. The act of industrialization of former raw materials areas in itself will augment the relative prosperity of the latter. There is no reason therefore why further settlement and industrialization may not go hand in hand.

GOALS OF NATIONAL POLICY

As a general working principle the acceptance of a bare subsistence standard for planned pioneer settlement may be condemned as a national policy, whether in Australia or Brazil. But settlers on their own initiative will also be looking for small doors of limited opportunity, not necessarily a gateway to the best the world affords. This may prove true of refugee settlement in particular. For refugees, a higher degree of tolerance of hard conditions has been assumed. Will it work out that way?

A scientific inquiry in each major area proposed for settlement can not stop short of the goal of acceptable livings. Granted that there must be wide tolerance at first on the part of almost all settlers, can an inventory of resources, area by area, assure them diversified production and enlargement of opportunity with endurably brief delay? Since most areas of potential settlement are marginal, can scientific inquiry reduce the risks? One may be sure that vast sums will not be spent in the post-war years upon doles to settlers who are badly located. There is every reason, however, why initial aid should be given to well-placed units who will add to the resources and taxable wealth of the countries of their adoption.

The abundance of unused land strikes every observer, yet it is the scarcity of commercially valuable unused land that intensifies the problem. The scientific study of settlement has become to a large degree a study of unused land. What keeps it out of production? Is the soil deficient? Is the water supply undependable? Are the required cultivation techniques peculiar? What is the natural imbalance that must be corrected by scientific study and treatment? The tsetse fly, natural *vs.* artificial vegetation, extreme price changes and soil erosion are among the examples we have mentioned.

No less important is a study in national psychologies. What is the attitude, country by country, toward the foreigner? What part in the shaping or retention of a recognized national attitude is played by experience with groups already established? Are the examples of Colonia Tovar, Cyrenaica and São Francisco correctly interpreted? What is the peculiar nature of the essential political processes in each country? How do the variant political processes play upon or determine migration policies? What are the specific economic equivalents of migration in industry and trade?

When the answers to these and other questions are given, not in the terms of a single specialty, but in the terms of a social and political mosaic, country by country, the science of settlement will have reached maturity. Sophistication of the investigator plays a part in finding practical answers: he must have that "nice tact of circumstances" which enables him to determine reasonably well what specific groups of men can do, or will do, or may be persuaded to do.

OBITUARY

EDWARD FRANKLIN GAINES

DR. EDWARD FRANKLIN GAINES, professor of genetics in agronomy and cerealist in the Agricultural Experiment Station of the State College of Washington, died on August 17 in a hospital after an illness which had confined him to his home for two years and to bed for the past year and a half.

He was born in Avalon, Missouri, on January 12, 1886, and moved with his family to Washington when a small boy. He graduated from the State Normal School at Cheney, Washington, in 1907, obtained his B.S. degree in 1911 and his M.S. degree in 1913 from the State College of Washington, and the Sc.D. degree from Harvard University in 1921.

Dr. Gaines joined the staff of the State College of Washington on July 1, 1911, as instructor in agronomy and assistant cerealist in the Experiment Station. He was advanced to the position of cerealist in 1917 and became professor of genetics in 1930.

Faced with the problem of smut which reached a climax in a large number of separator explosions in 1914, Dr. Gaines and his coworkers embarked upon